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(54) **TRANSLATION OF RESOURCE IDENTIFIERS USING POPULARITY INFORMATION UPON CLIENT REQUEST**

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See application file for complete search history.

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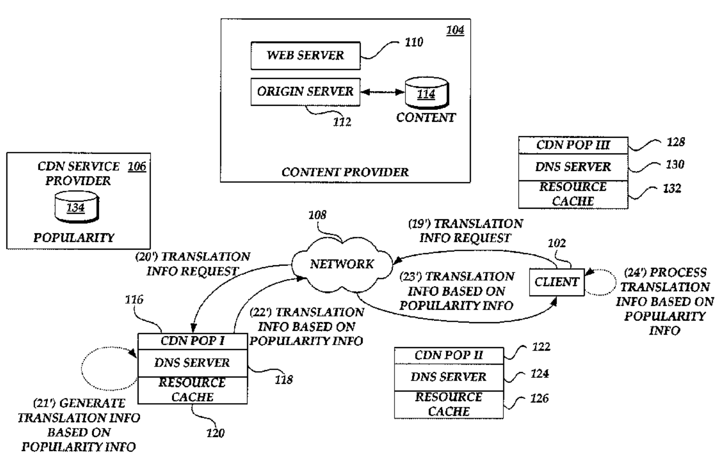
(57) **ABSTRACT**

A system, method and computer-readable medium for request routing based on content popularity information are provided. A client computer transmits a request for content from a content provider. The content provider utilizes executable code, such as translation request code, for facilitating request routing utilizing popularity information. The translation request code, may direct a client computing device to request further translation request code and/or translation information. Thereafter, the client issues a DNS query with the translated information including popularity information. The content delivery network service provider can then either resolve the DNS query with an IP address of a cache component or transmit another alternative resource identifier that will resolve to the content delivery network service provider. The process can repeat until a DNS nameserver resolves a DNS query from the client computing device.

20 Claims, 14 Drawing Sheets



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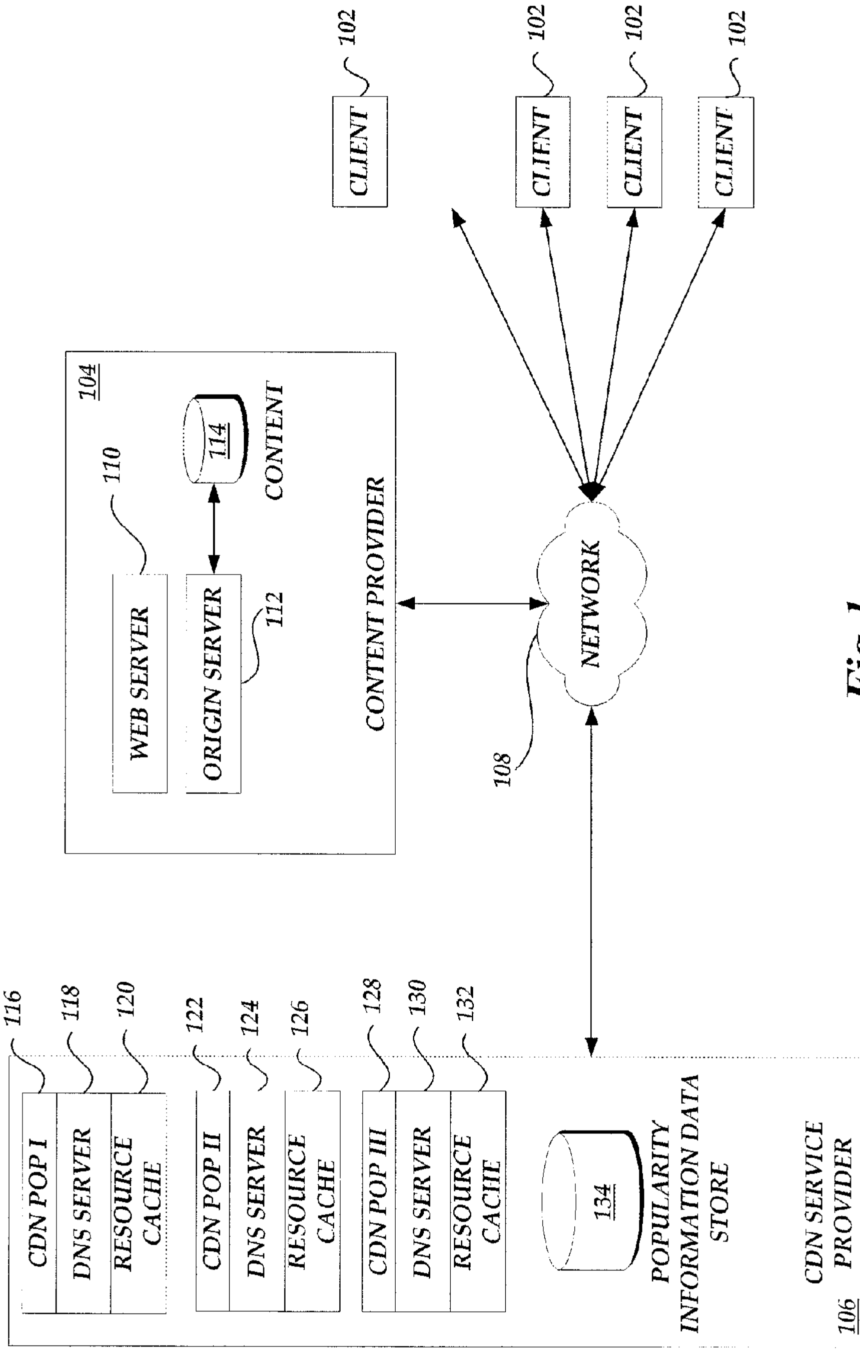

CLIENT
102
CLIENT
102
CLIENT
102
CLIENT
102
104
WEB SERVER
110
ORIGIN SERVER
112
114
CONTENT
CONTENT PROVIDER
NETWORK
108
CDN POP I
116
DNS SERVER
118
RESOURCE CACHE
120
CDN POP II
122
DNS SERVER
124
RESOURCE CACHE
126
CDN POP III
128
DNS SERVER
130
RESOURCE CACHE
132
134
POPULARITY INFORMATION DATA STORE
CDN SERVICE PROVIDER
106

Fig.1.

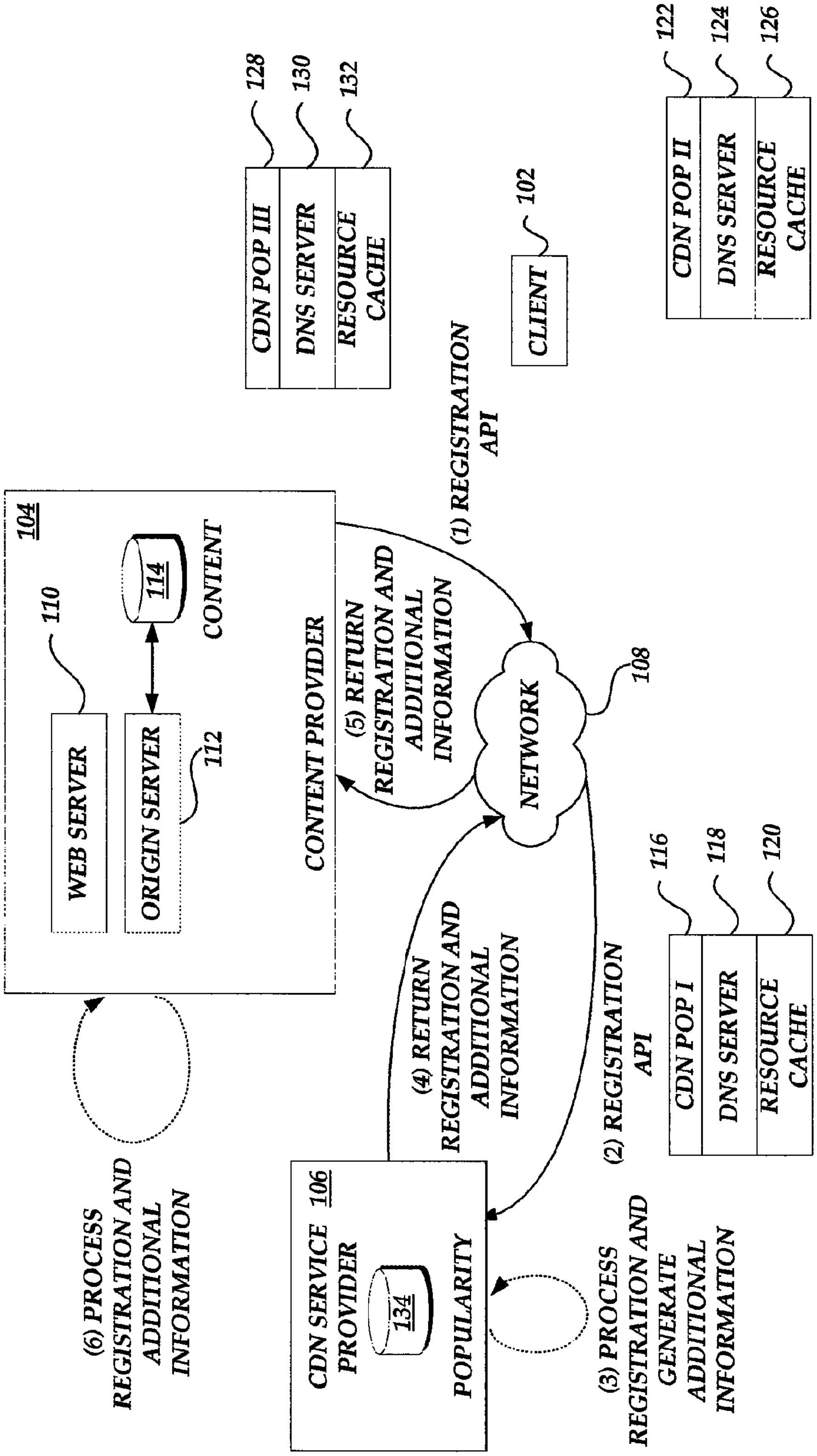
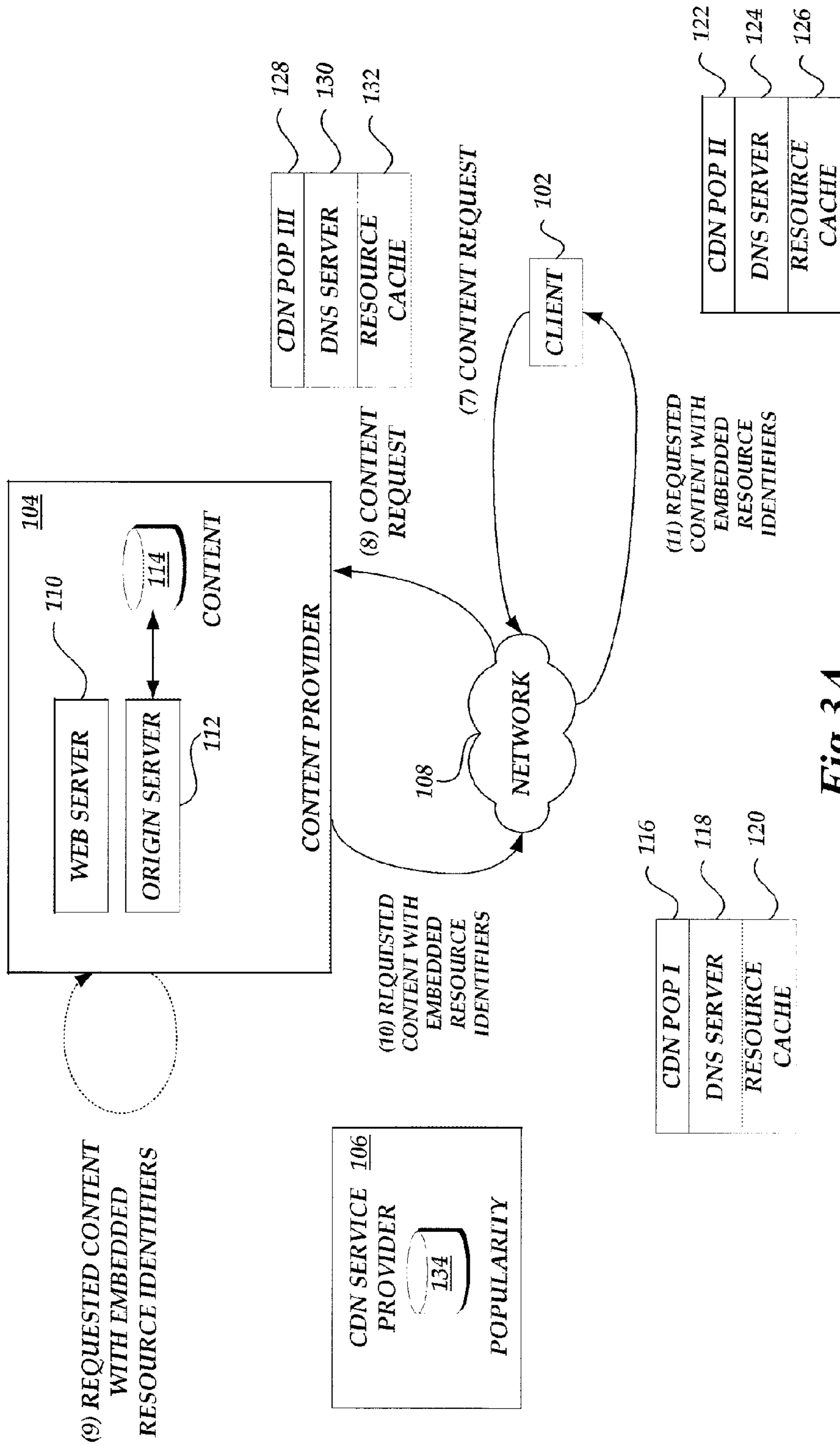
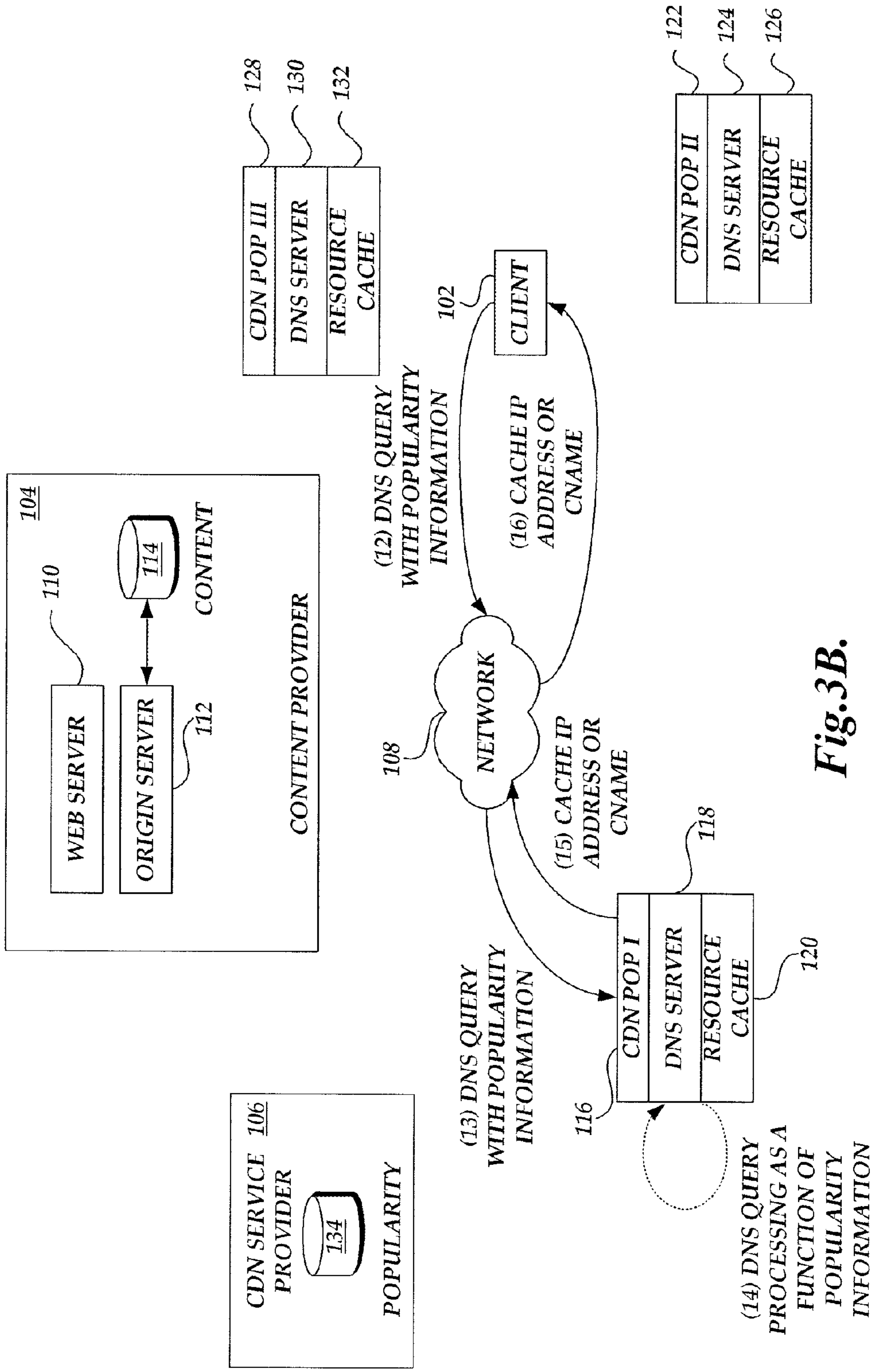

104
WEB SERVER
110
ORIGIN SERVER
112
114
CONTENT
CONTENT PROVIDER
CDN POP III
DNS SERVER
RESOURCE CACHE
128
130
132
CLIENT
102
CDN POP II
DNS SERVER
RESOURCE CACHE
122
124
126
(1) REGISTRATION API
(5) RETURN REGISTRATION AND ADDITIONAL INFORMATION
NETWORK
108
(4) RETURN REGISTRATION AND ADDITIONAL INFORMATION
(2) REGISTRATION API
CDN POP I
DNS SERVER
RESOURCE CACHE
116
118
120
CDN SERVICE PROVIDER
106
134
POPULARITY
(3) PROCESS REGISTRATION AND GENERATE ADDITIONAL INFORMATION
(6) PROCESS REGISTRATION AND ADDITIONAL INFORMATION

Fig.2.



104
WEB SERVER
110
ORIGIN SERVER
112
114
CONTENT
CONTENT PROVIDER
(9) REQUESTED CONTENT WITH EMBEDDED RESOURCE IDENTIFIERS
CDN SERVICE PROVIDER 106
134
POPULARITY
(8) CONTENT REQUEST
(10) REQUESTED CONTENT WITH EMBEDDED RESOURCE IDENTIFIERS
NETWORK
108
(7) CONTENT REQUEST
CLIENT
102
(11) REQUESTED CONTENT WITH EMBEDDED RESOURCE IDENTIFIERS
CDN POP III
DNS SERVER
RESOURCE CACHE
128
130
132
CDN POP II
DNS SERVER
RESOURCE CACHE
122
124
126
CDN POP I
DNS SERVER
RESOURCE CACHE
116
118
120

Fig.3A.



104
WEB SERVER
110
ORIGIN SERVER
112
114
CONTENT
CONTENT PROVIDER
CDN SERVICE PROVIDER 106
134
POPULARITY
CDN POP III
DNS SERVER
RESOURCE CACHE
128
130
132
CDN POP II
DNS SERVER
RESOURCE CACHE
122
124
126
CLIENT
102
(12) DNS QUERY WITH POPULARITY INFORMATION
(16) CACHE IP ADDRESS OR CNAME
NETWORK
108
(15) CACHE IP ADDRESS OR CNAME
(13) DNS QUERY WITH POPULARITY INFORMATION
CDN POP I
DNS SERVER
RESOURCE CACHE
116
118
120
(14) DNS QUERY PROCESSING AS A FUNCTION OF POPULARITY INFORMATION

Fig.3B.

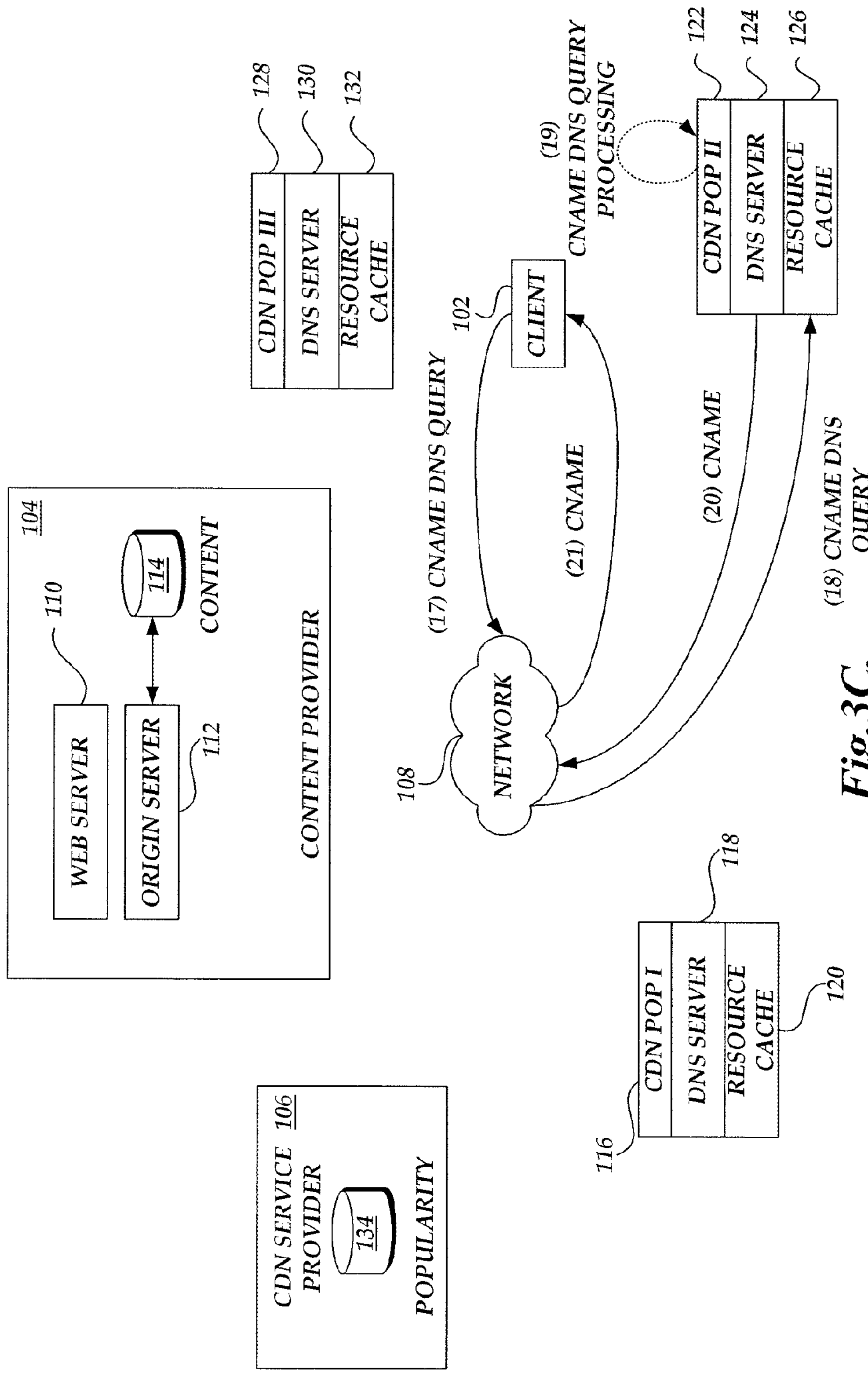
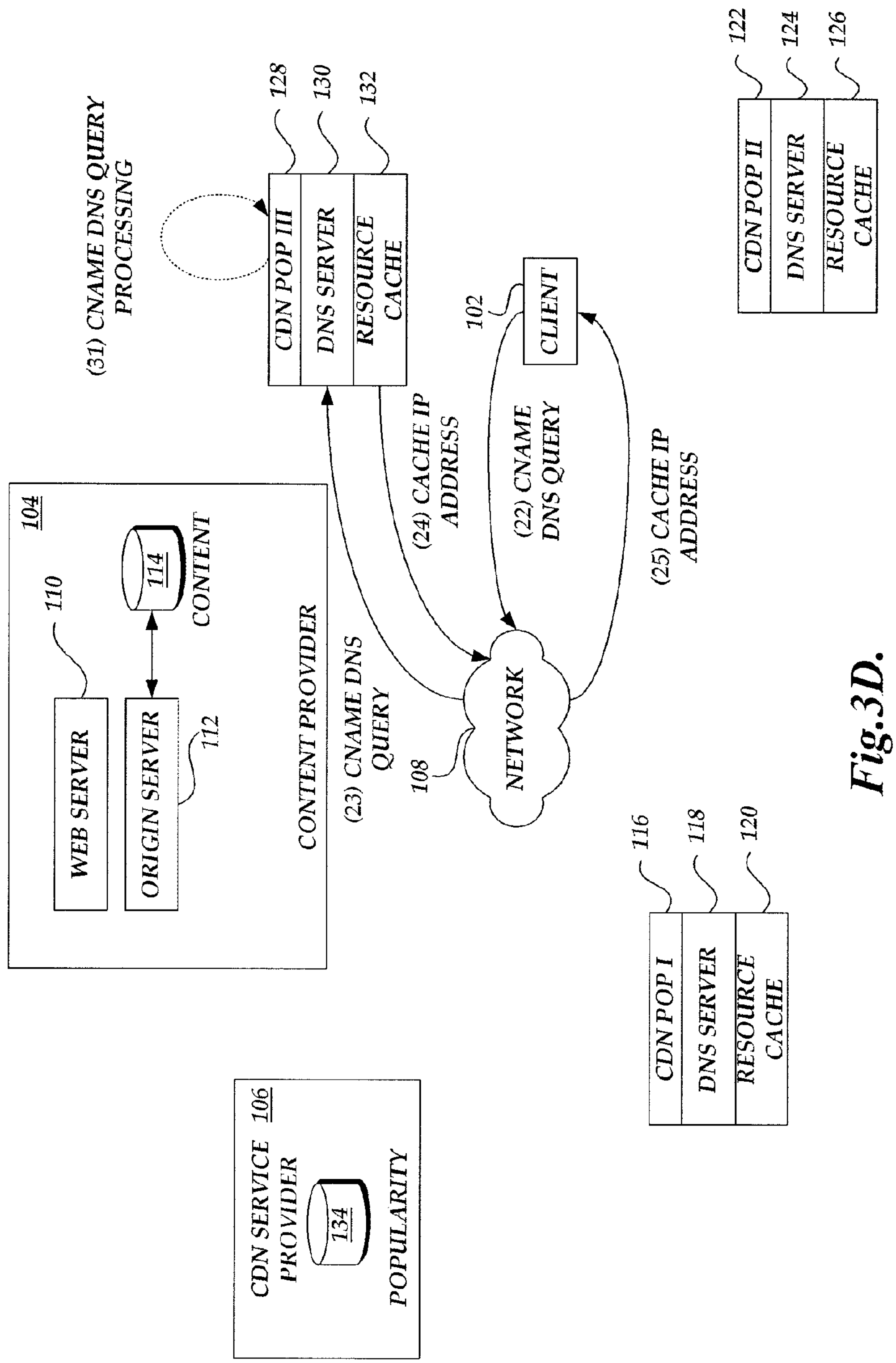
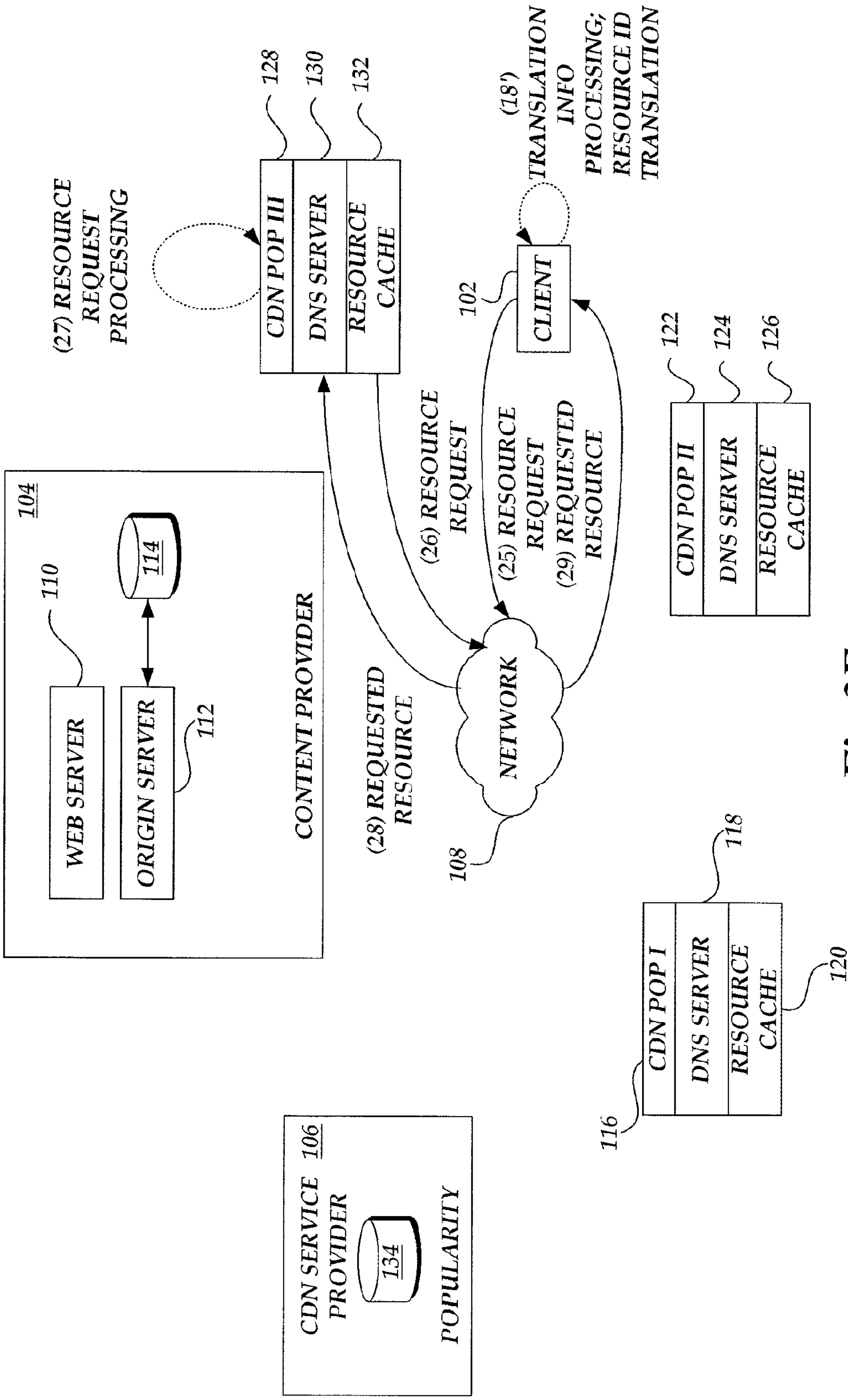

104
110
WEB SERVER
ORIGIN SERVER
112
114
CONTENT
CONTENT PROVIDER
CDN SERVICE PROVIDER 106
134
POPULARITY
128
130
132
CDN POP III
DNS SERVER
RESOURCE CACHE
102
CLIENT
(17) CNAME DNS QUERY
(21) CNAME
108
NETWORK
(19) CNAME DNS QUERY PROCESSING
122
124
126
CDN POP II
DNS SERVER
RESOURCE CACHE
(20) CNAME
(18) CNAME DNS QUERY
118
116
CDN POP I
DNS SERVER
RESOURCE CACHE
120

Fig.3C.



(31) CNAME DNS QUERY PROCESSING
128
130
132
CDN POP III
DNS SERVER
RESOURCE CACHE
122
124
126
CDN POP II
DNS SERVER
RESOURCE CACHE
102
CLIENT
(24) CACHE IP ADDRESS
(22) CNAME DNS QUERY
(25) CACHE IP ADDRESS
104
110
WEB SERVER
114
CONTENT
ORIGIN SERVER
112
CONTENT PROVIDER
(23) CNAME DNS QUERY
108
NETWORK
116
118
120
CDN POP I
DNS SERVER
RESOURCE CACHE
CDN SERVICE PROVIDER 106
134
POPULARITY

Fig.3D.



104
110
WEB SERVER
114
ORIGIN SERVER
112
CONTENT PROVIDER
(27) RESOURCE REQUEST PROCESSING
128
130
132
CDN POP III
DNS SERVER
RESOURCE CACHE
(18') TRANSLATION INFO PROCESSING; RESOURCE ID TRANSLATION
102
CLIENT
(26) RESOURCE REQUEST
(25) RESOURCE REQUEST
(29) REQUESTED RESOURCE
(28) REQUESTED RESOURCE
NETWORK
108
122
124
126
CDN POP II
DNS SERVER
RESOURCE CACHE
118
CDN POP I
DNS SERVER
RESOURCE CACHE
120
116
CDN SERVICE PROVIDER 106
134
POPULARITY

Fig.3E.

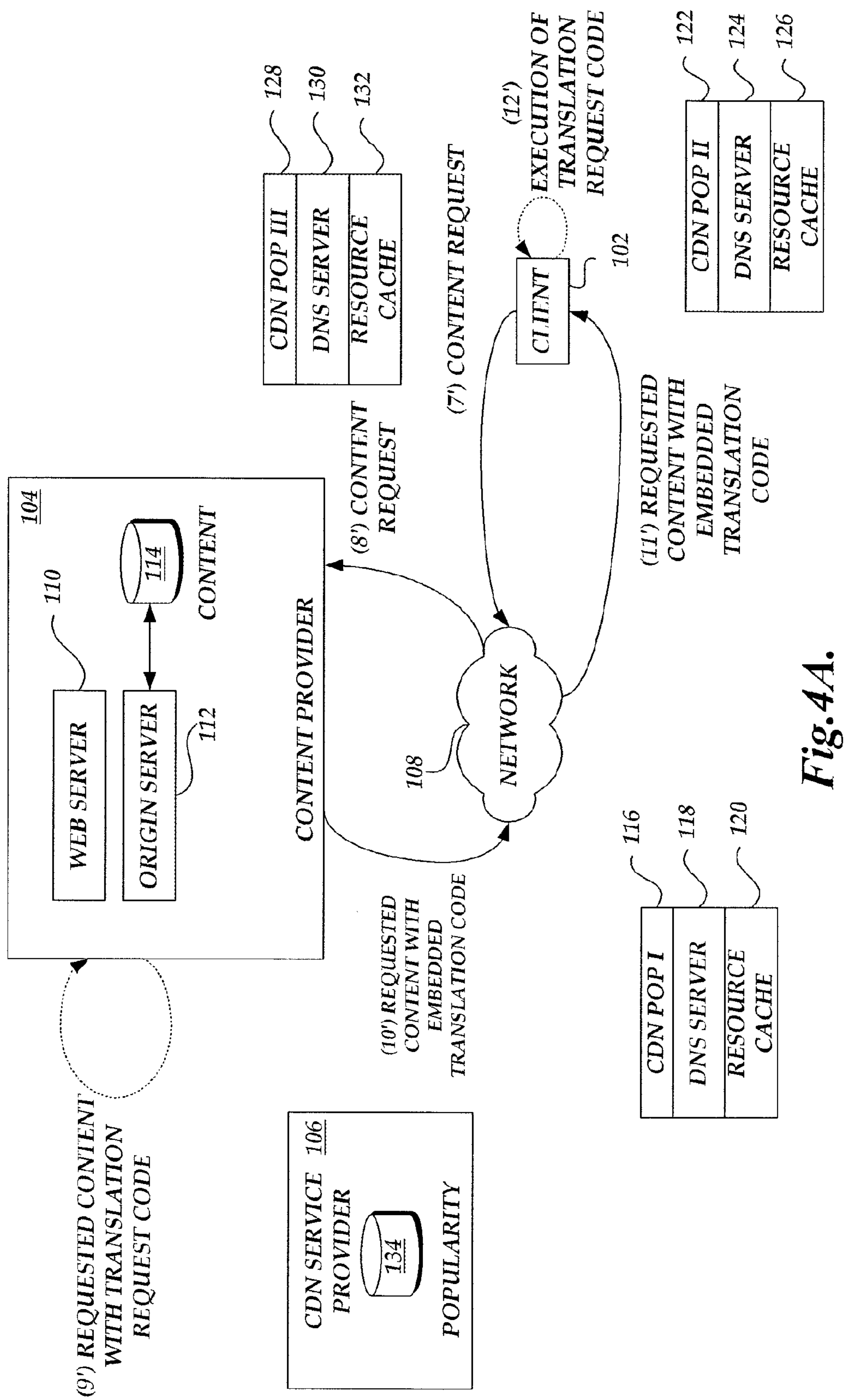

104
CONTENT PROVIDER
WEB SERVER
110
ORIGIN SERVER
112
114
CONTENT
(9') REQUESTED CONTENT WITH TRANSLATION REQUEST CODE
(8') CONTENT REQUEST
(10') REQUESTED CONTENT WITH EMBEDDED TRANSLATION CODE
NETWORK
108
(7') CONTENT REQUEST
(11') REQUESTED CONTENT WITH EMBEDDED TRANSLATION CODE
CLIENT
102
(12') EXECUTION OF TRANSLATION REQUEST CODE
CDN POP III
DNS SERVER
RESOURCE CACHE
128
130
132
CDN POP II
DNS SERVER
RESOURCE CACHE
122
124
126
CDN POP I
DNS SERVER
RESOURCE CACHE
116
118
120
CDN SERVICE PROVIDER
106
134
POPULARITY

Fig.4A.

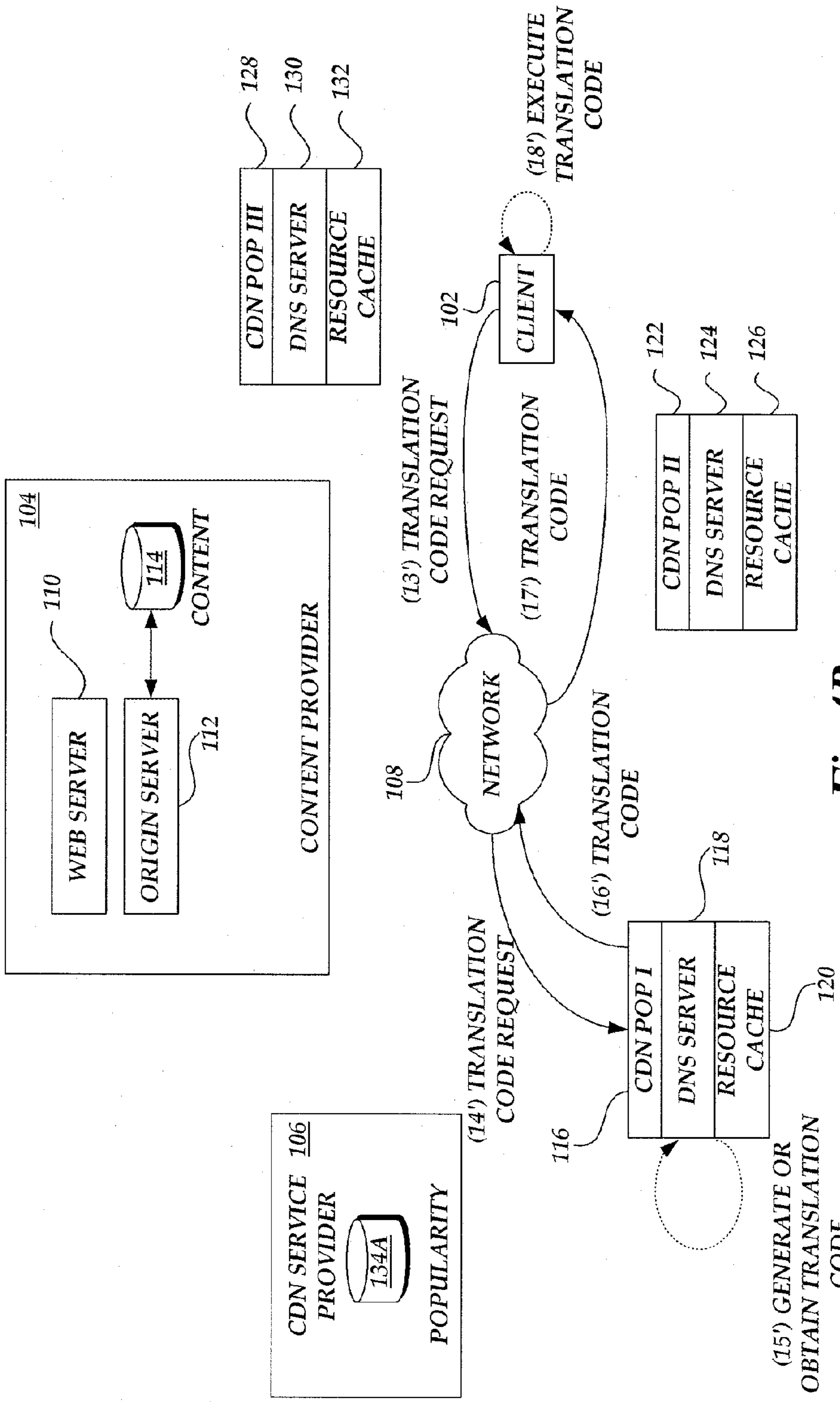

104
110
WEB SERVER
ORIGIN SERVER
112
114
CONTENT
CONTENT PROVIDER
128
130
132
CDN POP III
DNS SERVER
RESOURCE CACHE
(18') EXECUTE TRANSLATION CODE
102
CLIENT
(13') TRANSLATION CODE REQUEST
(17') TRANSLATION CODE
122
124
126
CDN POP II
DNS SERVER
RESOURCE CACHE
108
NETWORK
(16') TRANSLATION CODE
118
(14') TRANSLATION CODE REQUEST
CDN POP I
DNS SERVER
RESOURCE CACHE
116
120
(15') GENERATE OR OBTAIN TRANSLATION CODE
CDN SERVICE PROVIDER 106
134A
POPULARITY

Fig.4B.

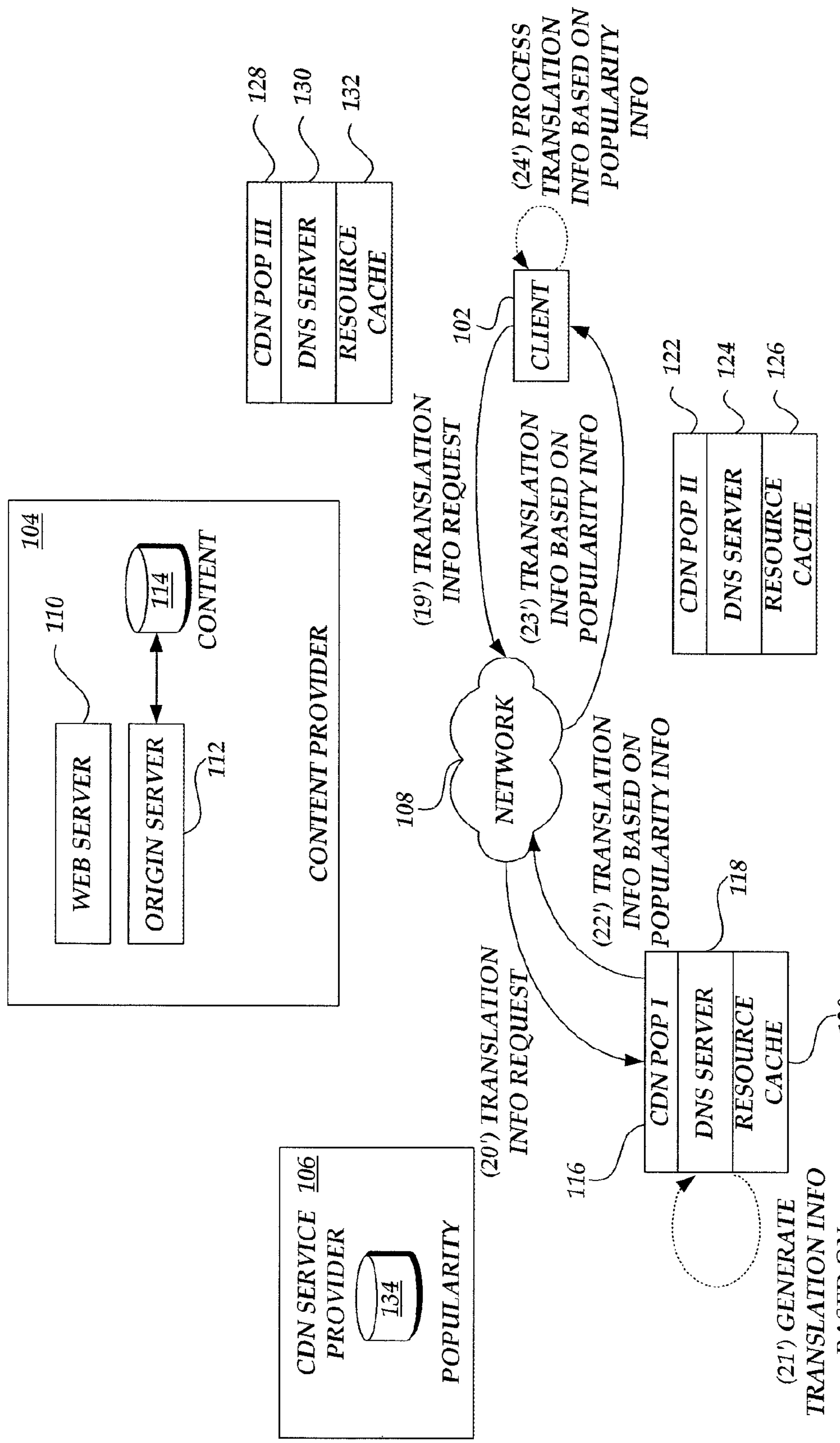

104
WEB SERVER
110
ORIGIN SERVER
112
114
CONTENT
CONTENT PROVIDER
CDN SERVICE PROVIDER 106
134
POPULARITY
CDN POP III
DNS SERVER
RESOURCE CACHE
128
130
132
CLIENT
102
(24') PROCESS TRANSLATION INFO BASED ON POPULARITY INFO
(19') TRANSLATION INFO REQUEST
(23') TRANSLATION INFO BASED ON POPULARITY INFO
CDN POP II
DNS SERVER
RESOURCE CACHE
122
124
126
NETWORK
108
(22') TRANSLATION INFO BASED ON POPULARITY INFO
118
(20') TRANSLATION INFO REQUEST
CDN POP I
DNS SERVER
RESOURCE CACHE
116
120
(21') GENERATE TRANSLATION INFO BASED ON POPULARITY INFO

Fig.4C.

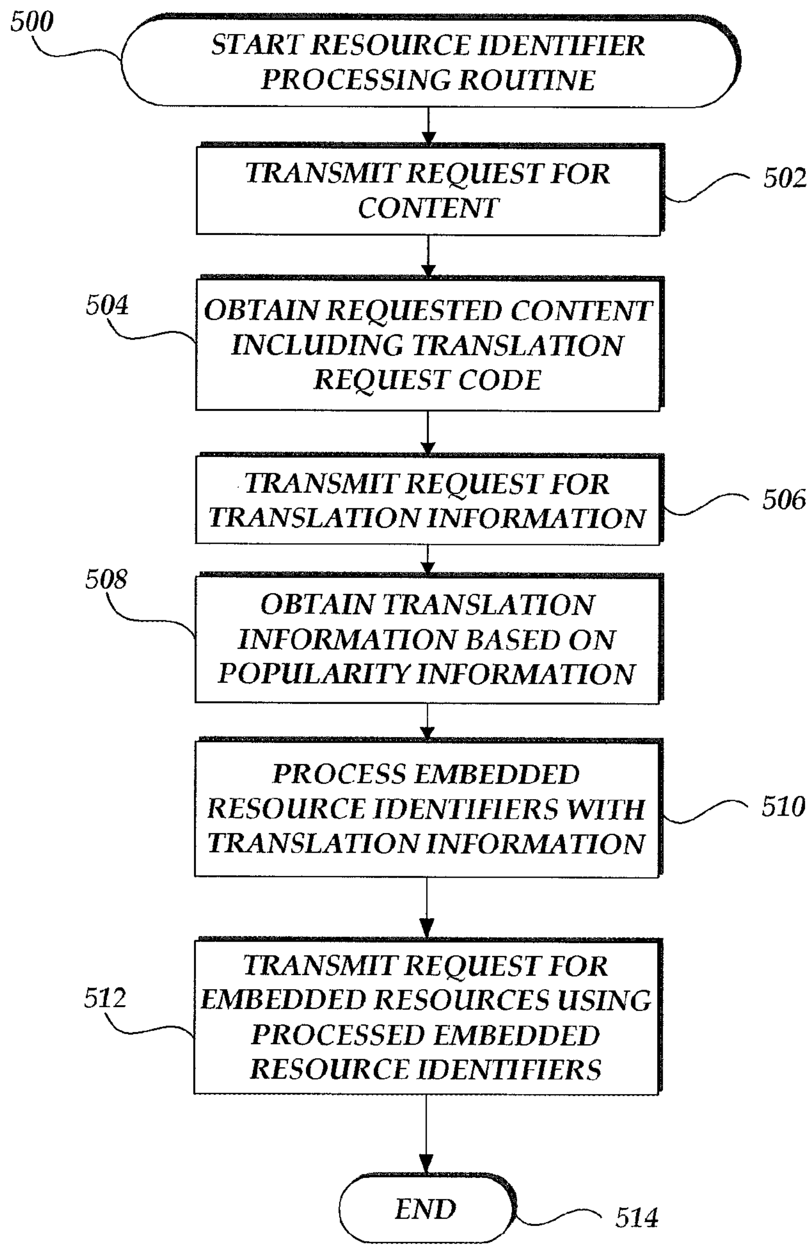

500
START RESOURCE IDENTIFIER PROCESSING ROUTINE
TRANSMIT REQUEST FOR CONTENT
502
504
OBTAIN REQUESTED CONTENT INCLUDING TRANSLATION REQUEST CODE
TRANSMIT REQUEST FOR TRANSLATION INFORMATION
506
508
OBTAIN TRANSLATION INFORMATION BASED ON POPULARITY INFORMATION
PROCESS EMBEDDED RESOURCE IDENTIFIERS WITH TRANSLATION INFORMATION
510
512
TRANSMIT REQUEST FOR EMBEDDED RESOURCES USING PROCESSED EMBEDDED RESOURCE IDENTIFIERS
END
514

Fig.5A.

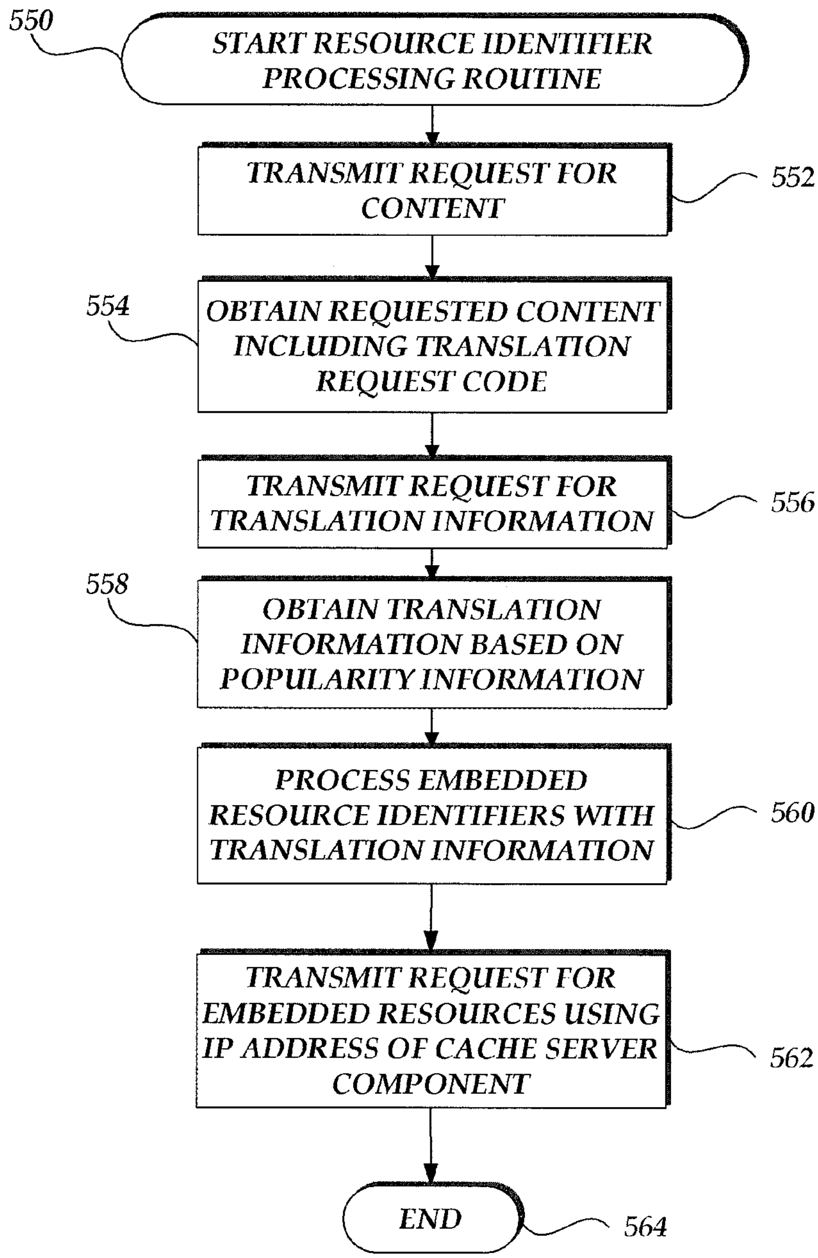

550
START RESOURCE IDENTIFIER PROCESSING ROUTINE
TRANSMIT REQUEST FOR CONTENT
552
554
OBTAIN REQUESTED CONTENT INCLUDING TRANSLATION REQUEST CODE
TRANSMIT REQUEST FOR TRANSLATION INFORMATION
556
558
OBTAIN TRANSLATION INFORMATION BASED ON POPULARITY INFORMATION
PROCESS EMBEDDED RESOURCE IDENTIFIERS WITH TRANSLATION INFORMATION
560
TRANSMIT REQUEST FOR EMBEDDED RESOURCES USING IP ADDRESS OF CACHE SERVER COMPONENT
562
END
564

Fig.5B.

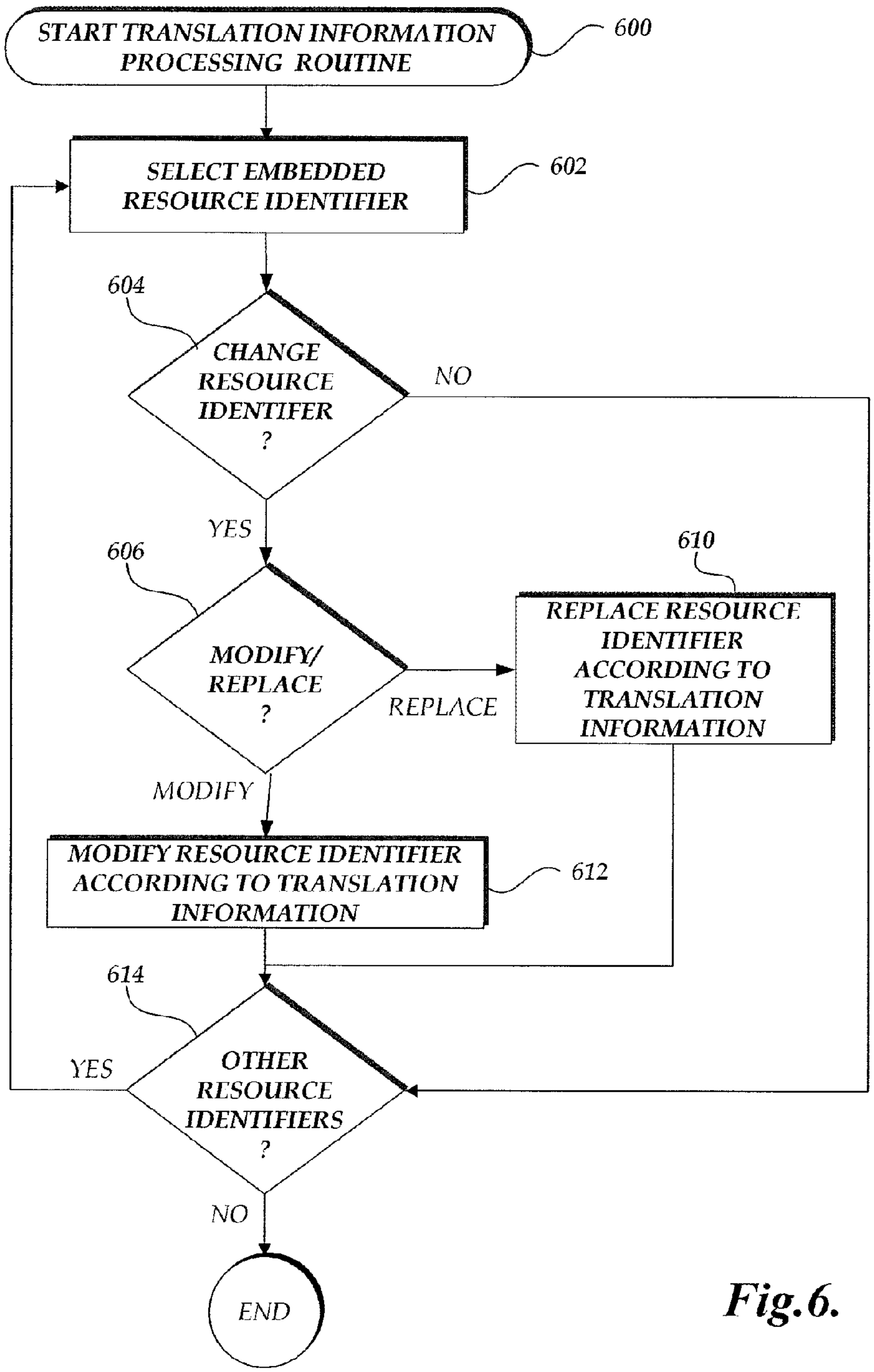

START TRANSLATION INFORMATION PROCESSING ROUTINE
600
SELECT EMBEDDED RESOURCE IDENTIFIER
602
604
CHANGE RESOURCE IDENTIFER ?
NO
YES
606
MODIFY/ REPLACE ?
REPLACE
610
REPLACE RESOURCE IDENTIFIER ACCORDING TO TRANSLATION INFORMATION
MODIFY
MODIFY RESOURCE IDENTIFIER ACCORDING TO TRANSLATION INFORMATION
612
614
YES
OTHER RESOURCE IDENTIFIERS ?
NO
END

Fig.6.

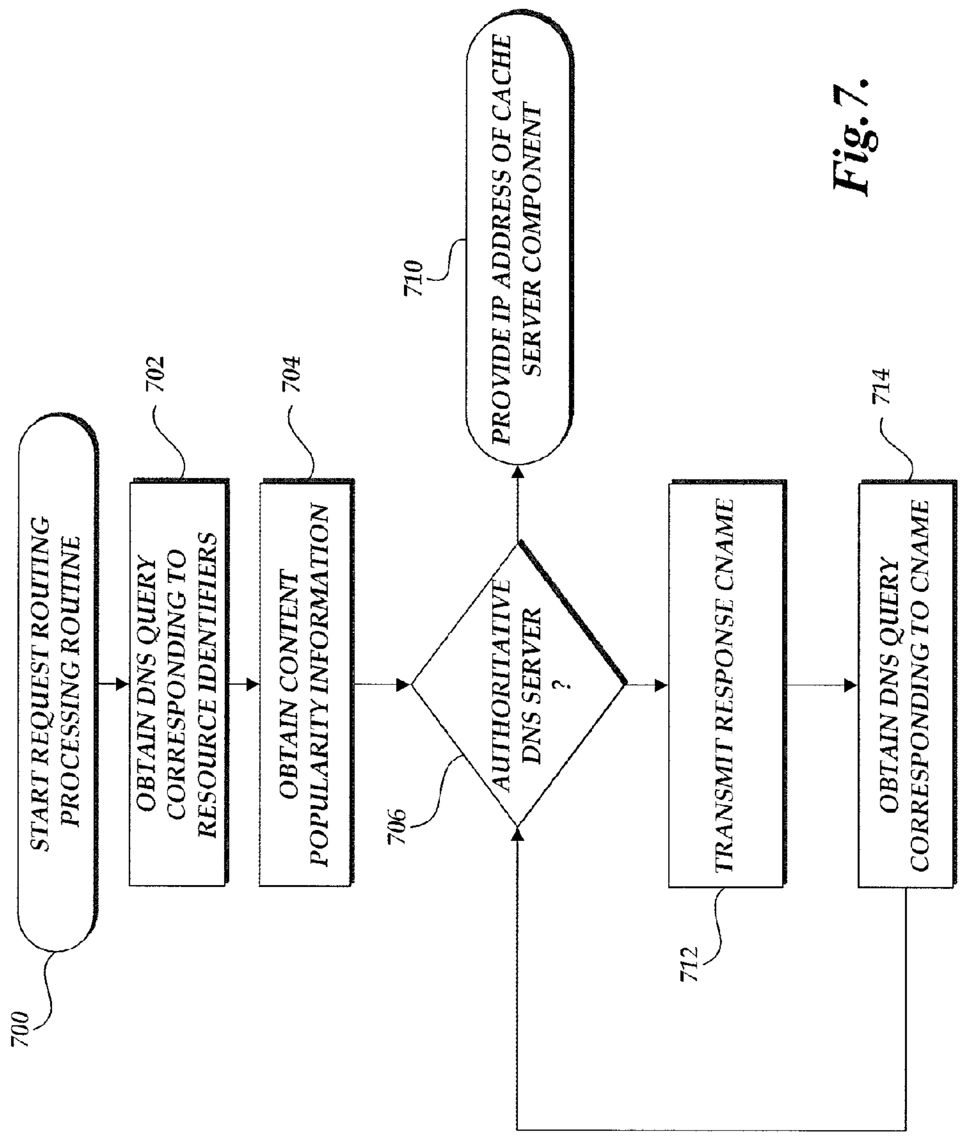

700
START REQUEST ROUTING PROCESSING ROUTINE
702
OBTAIN DNS QUERY CORRESPONDING TO RESOURCE IDENTIFIERS
704
OBTAIN CONTENT POPULARITY INFORMATION
706
AUTHORITATIVE DNS SERVER ?
710
PROVIDE IP ADDRESS OF CACHE SERVER COMPONENT
712
TRANSMIT RESPONSE CNAME
714
OBTAIN DNS QUERY CORRESPONDING TO CNAME

Fig. 7.

TRANSLATION OF RESOURCE IDENTIFIERS USING POPULARITY INFORMATION UPON CLIENT REQUEST

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/621,062 entitled "DYNAMICALLY TRANSLATING RESOURCE IDENTIFIERS FOR REQUEST ROUTING USING POPULARITY INFORMATION" and filed on Sep. 15, 2012, which in turn is a divisional of U.S. patent application Ser. No. 12/412,467 entitled "DYNAMICALLY TRANSLATING RESOURCE IDENTIFIERS FOR REQUEST ROUTING UTILIZING CONTENT CHARACTERISTICS" and filed on Mar. 27, 2009, which is related to U.S. patent application Ser. No. 12/412,456 entitled "REQUEST ROUTING USING POPULARITY INFORMATION" and filed on Mar. 27, 2009, the disclosures of which are incorporated herein by reference.

BACKGROUND

Generally described, computing devices and communication networks can be utilized to exchange information. In a common application, a computing device can request content from another computing device via the communication network. For example, a user at a personal computing device can utilize a software browser application to request a Web page from a server computing device via the Internet. In such embodiments, the user computing device can be referred to as a client computing device and the server computing device can be referred to as a content provider.

Content providers are generally motivated to provide requested content to client computing devices, often with consideration of efficient transmission of the requested content to the client computing device and/or consideration of a cost associated with the transmission of the content. For larger scale implementations, a content provider may receive content requests from a high volume of client computing devices which can place a strain on the content provider's computing resources. Additionally, the content requested by the client computing devices may have a number of components, which can further place additional strain on the content provider's computing resources.

Some content providers attempt to facilitate the delivery of requested content, such as Web pages and/or resources identified in Web pages, through the utilization of a content delivery network ("CDN") service provider. A CDN server provider typically maintains a number of computing devices in a communication network that can maintain content from various content providers. In turn, content providers can instruct, or otherwise suggest to, client computing devices to request some, or all, of the content provider's content from the CDN service provider's computing devices. Upon receipt of resource requests from such client computing devices, a CDN service provider typically delivers the requested resource in accordance with terms (such as via a service plan) specified between a corresponding content provider and the CDN service provider.

As with content providers, network storage providers and CDN service providers are also generally motivated to provide requested content to client computing devices often with consideration of efficient transmission of the requested content to the client computing device and/or consideration of a cost associated with the transmission of the content. Accordingly, CDN service providers often consider factors such as latency of delivery of requested content in order to meet service level agreements or to generally improve the quality of delivery service.

In an illustrative example, a CDN service provider may employ computing devices that are placed at selected locations within the communications network. Through placement of the computing devices, as well as the selection of content maintained by the computing devices, the CDN service provider may direct content requests to computing devices that possess sufficient capacity to respond and/or are relatively close to the requesting client computing devices. In this manner, the CDN service provider may achieve reductions in latency and better manage capacity, improving quality of service.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a block diagram illustrative of a content delivery environment including a number of client computing devices, content provider, and a content delivery network service provider;

FIG. **2** is a block diagram of the content delivery environment of FIG. **1** illustrating the registration of a content provider with a content delivery service provider;

FIG. **3**A is a block diagram of the content delivery environment of FIG. **1** illustrating the generation and processing of a content request from a client computing device to a content provider and delivery of content including embedded resource identifiers from the content provider to the client computing device;

FIG. **3**B is a block diagram of the content delivery environment of FIG. **1** illustrating the generation and processing of a DNS query corresponding to an embedded resource from a client computing device to a content delivery network service provider;

FIG. **3**C is a block diagram of the content delivery environment of FIG. **1** illustrating the generation and processing of a DNS query corresponding to a first alternative resource identifier from a client computing device to a content delivery network service provider;

FIG. **3**D is a block diagram of the content delivery environment of FIG. **1** illustrating the generation and processing of a DNS query corresponding to a second alternative resource identifier from a client computing device to a content delivery network service provider;

FIG. **3**E is a block diagram of the content delivery environment of FIG. **1** illustrating the generation and processing of embedded resource requests from a client computing device to a content delivery network service provider;

FIG. **4**A is a block diagram of the content delivery environment of FIG. **1** illustrating the generation and processing of a content request from a client computing device to a content provider and a delivery of content including embedded translation code from the content provider to the client computing device;

FIG. **4**B is a block diagram of the content delivery environment of FIG. **1** illustrating the generation and processing of a translation code request from a client computing device to a point of presence (POP) of a content delivery network;

FIG. **4**C is a block diagram of the content delivery environment of FIG. **1** illustrating the generation and processing of a translation information request from a client computing device to a content delivery network service provider;

FIGS. **5**A and **5**B are flow diagrams illustrative of resource identifier processing routines implemented by a client computing device to process embedded resource identifiers with translation information provided by a content delivery network service provider;

FIG. **6** is a flow diagram illustrative of an embodiment of a translation information processing routine implemented by a client computing device for employing translation information received from a content delivery network; and

FIG. **7** is a flow diagram illustrative of another embodiment of a request routing routine implemented by a content delivery network service provider for selecting a cache server or network computing component.

DETAILED DESCRIPTION

Generally described, the present disclosure is directed to the routing of DNS queries from a client computing device corresponding to content requests that are performed by a network resource, such as content delivery network ("CDN") service providers. The processing of a DNS query by a CDN service provider is generally referred to as request routing. Specifically, aspects of the disclosure will be described with regard to the routing of a client computing device DNS query within a content delivery network service provider domain as a function of popularity information associated with the resources requested by the client computing device. Examples of popularity information may include, but are not limited to, a ranking of received requests from client computing devices, a total number of received requests from client computing devices, a frequency of received requests, an identification of one or more popularity categories or hierarchies (e.g., high, medium, low, etc.), and the like.

In certain embodiments, popularity information may be included within the resource identifiers utilized in the DNS queries received by the CDN service provider from the client computing device. In other embodiments, the DNS queries may include information that permits the CDN service provider to retrieve popularity information associated with the requested resources. In either case, upon determining the popularity information for the requested resources, the CDN service provider may select components of a CDN network on the basis of this popularity information to process resource requests from client computing devices. (e.g., request routing based at least in part on popularity information). For example, a CDN service provider may route DNS queries for highly popular resources (as defined by popularity information) to one or more particular point of presence location(s) that are relatively close to the client computing device, while DNS queries for less popular resources may be routed to one or more particular point of presence location(s) that may not be as relatively close. Although various aspects of the disclosure will be described with regard to illustrative examples and embodiments, one skilled in the art will appreciate that the disclosed embodiments and examples should not be construed as limiting.

FIG. **1** is a block diagram illustrative of content delivery environment **100** for the management and processing of content requests. As illustrated in FIG. **1**, the content delivery environment **100** may include a number of client computing devices **102** (generally referred to as clients) for requesting content from a content provider and/or a CDN service provider. In an illustrative embodiment, the client computing devices **102** can correspond to a wide variety of computing devices including personal computing devices, laptop computing devices, hand-held computing devices, terminal computing devices, mobile devices, wireless devices, various electronic devices and appliances, and the like. In an illustrative embodiment, the client computing devices **102** may include necessary hardware and software components for establishing communications over a communication network **108**, such as a wide area network or local area network. For example, the client computing devices **102** may be equipped with networking equipment and browser software applications that facilitate communications via the Internet or an intranet.

Although not illustrated in FIG. **1**, each client computing device **102** may utilize some type of local DNS resolver component, such as a DNS nameserver, that generates the DNS queries attributed to the client computing device **102**. In one embodiment, the local DNS resolver component may be provided by an enterprise network to which the client computing device **102** belongs. In another embodiment, the local DNS resolver component may be provided by an Internet Service Provider (ISP) that provides the communication network connection to the client computing device **102**.

The content delivery environment **100** can also include a content provider **104** in communication with the one or more client computing devices **102** via the communication network **108**. The content provider **104** illustrated in FIG. **1** corresponds to a logical association of one or more computing devices associated with a content provider. Specifically, the content provider **104** can include a web server component **110** corresponding to one or more server computing devices for obtaining and processing requests for content (such as Web pages) from the client computing devices **102**. The content provider **104** can further include an origin server component **112** and associated storage component **114** corresponding to one or more computing devices for obtaining and processing requests for network resources from the CDN service provider.

One skilled in the relevant art will appreciate that the content provider **104** can be associated with various additional computing resources, such as additional computing devices for administration of content and resources, DNS nameservers, and the like. For example, although not illustrated in FIG. **1**, the content provider **104** can be associated with one or more DNS nameserver components that receive DNS queries associated with the domain of the content provider **104** and that would be authoritative to resolve client computing device DNS queries corresponding to a domain of the content provider (e.g., return an IP address responsive to the DNS query). A DNS nameserver component is considered to be authoritative to a DNS query if the DNS nameserver can completely resolve the query by providing a responsive IP address. Additionally, the content provider **104** may omit some of the components illustrated in FIG. **1**, such as origin server **112**.

With continued reference to FIG. **1**, the content delivery environment **100** can further include a CDN service provider **106** in communication with the one or more client computing devices **102** and the content provider **104** via the communication network **108**. The CDN service provider **106** illustrated in FIG. **1** corresponds to a logical association of one or more computing devices associated with a CDN service provider. Specifically, the CDN service provider **106** can include a number of Point of Presence ("POP") locations **116**, **122**, **128** that correspond to nodes on the communication network **108**. Each POP **116**, **122**, **128** includes a DNS component **118**, **124**, **130** made up of a number of DNS nameserver computing devices for resolving DNS queries from the client computers **102**. Each POP **116**, **122**, **128** also includes a resource cache component **120**, **126**, **132** made up of a number of cache server computing devices for storing resources from content providers and transmitting various requested resources to various client computers.

Still further, the CDN service provider **106** may include a popularity information data store **134** for maintaining popularity information regarding resources provided on behalf of one or more various content providers **104**. The popularity information data store **134** can also maintain popularity information associated with content requests received by each of the POPs **116**, **122**, **128**. In an illustrative embodiment, the popularity information data store **134** may correspond to a central data store accessible by the POPs **116**, **122**, **128**, such as via a Web service. In another embodiment, each POP **116**, **122**, **128** can maintain a local version of a popularity information data store **134** for utilization in request routing as will be explained in greater detail. Additionally, although the popularity information data store **134** is illustrated as a single data store, one skilled in the relevant art will appreciate that popularity information data store **134** may correspond to one or more data stores which may be implemented in a distributed manner.

The DNS components **118**, **124**, **130** and the resource cache components **120**, **126**, **132** may further include additional software and/or hardware components that facilitate communications including, but not limited to, load balancing or load sharing software/hardware components. In an illustrative embodiment, the DNS component **118**, **124**, **130** and resource cache component **120**, **126**, **132** are considered to be logically grouped, regardless of whether the components, or portions of the components, are physically separate. Additionally, although the POPs **116**, **122**, **128** are illustrated in FIG. **1** as logically associated with the CDN service provider **106**, the POPs will be geographically distributed throughout the communication network **108** in a manner to best serve various demographics of client computing devices **102**. Additionally, one skilled in the relevant art will appreciate that the CDN service provider **106** can be associated with various additional computing resources, such as additional computing devices for administration of content and resources, and the like.

With reference now to FIG. **2**, the interaction between various components of the content delivery environment **100** of FIG. **1** will be illustrated. For purposes of the example, however, the illustration has been simplified such that many of the components utilized to facilitate communications are not shown. One skilled in the relevant art will appreciate that such components can be utilized and that additional interactions would accordingly occur without departing from the spirit and scope of the present disclosure.

With reference to FIG. **2**, an illustrative interaction for registration of a content provider **104** with the CDN service provider **106** will be described. As illustrated in FIG. **2**, the CDN content registration process begins with registration of the content provider **104** with the CDN service provider **106**. In an illustrative embodiment, the content provider **104** utilizes a registration application program interface ("API") to register with the CDN service provider **106** such that the CDN service provider **106** can provide content on behalf of the content provider **104**. The registration API includes the identification of the origin server **112** of the content provider **104** that will provide requested resources to the CDN service provider **106**. Additionally, the registration API can further facilitate the specification of the content provider, service levels, financial cost criteria, or other content provider specified criteria that can be utilized by the CDN service provider **106** in request routing processing.

One skilled in the relevant art will appreciate that upon identification of appropriate origin servers **112**, the content provider **104** can begin to direct requests for content from client computing devices **102** to the CDN service provider **106**. Specifically, in accordance with DNS routing principles, a client computing device request corresponding to a resource identifier would eventually be directed toward a POP **116**, **122**, **128** associated with the CDN service provider **106**. In the event that the resource cache component **120**, **126**, **132** of a selected POP does not have a copy of a resource requested by a client computing device **102**, the resource cache component will request the resource from the origin server **112** previously registered by the content provider **104**.

With continued reference to FIG. **2**, upon receiving the registration API, the CDN service provider **106** obtains and processes the registration information. In an illustrative embodiment, the CDN service provider **106** can then generate additional information that will be used by the client computing devices **102** as part of the content requests. The additional information can include, without limitation, client identifiers, such as client identification codes, content provider identifiers, such as content provider identification codes, popularity information identifiers, executable code for processing resource identifiers, such as script-based instructions, resource identifiers (e.g., URLs) that identify an applicable domain from which such script-based instructions may be obtained, and the like. One skilled in the relevant art will appreciate that various types of additional information may be generated by the CDN service provider **106** and that the additional information may be embodied in any one of a variety of formats. The CDN service provider **106** returns an identification of applicable domains for the CDN service provider (unless it has been previously provided) and any additional information to the content provider **104**. In turn, the content provider **104** can then process the stored resource identifiers in accordance with the content provider specified information.

In one example, as illustrated in FIG. **2**, the content provider **104** translates resource identifiers originally directed toward a domain of the origin server **112** to a domain corresponding to the CDN service provider. The modified URLs are embedded into requested content in a manner such that DNS queries for the modified URLs will resolve to a DNS server corresponding to the CDN service provider **106** and not a DNS nameserver corresponding to the content provider **104**. Although the translation process is illustrated in FIG. **2**, in some embodiments, the translation process may be omitted in a manner described in greater detail below.

Generally, the identification of the resources originally directed to the content provider **104** will be in the form of a resource identifier that can be processed by the client computing device **102**, such as through a browser software application. In an illustrative embodiment, the resource identifiers can be in the form of a uniform resource locator ("URL"). Because the resource identifiers are included in the requested content directed to the content provider, the resource identifiers can be referred to generally as the "content provider URL." For purposes of an illustrative example, the content provider URL can identify a domain of the content provider **104** (e.g., contentprovider.com), a name of the resource to be requested (e.g., "resource.xxx") and a path where the resource will be found (e.g., "path"). In this illustrative example, the content provider URL has the form of:

http://www.contentprovider.com/path/resource.xxx

During an illustrative translation process, the content provider URL is modified such that requests for the resources associated with the modified URLs resolve to a POP associated with the CDN service provider **106**. In one embodiment, the modified URL identifies the domain of the CDN service provider **106** (e.g., "cdnprovider.com"), the same name of the resource to be requested (e.g., "resource.xxx") and the same path where the resource will be found (e.g., "path"). Additionally, the modified URL can include various additional pieces of information utilized by the CDN service provider **106** during the request routing process. Specifically, in an illustrative embodiment, the modified URL can include data indicative of popularity information corresponding to information or criteria utilized by the CDN service provider **106** during the request routing process ("popularity information"). As described above, the popularity of a resource (or set of resources) can be defined in a variety of ways including, but not limited to, a ranking or other prioritization of a resource relative to other resources, the frequency at which resources are requested at the CDN service provider **106**, a total number of requests for an identified resource, an identification of one or more popularity categories or hierarchies (e.g., high, medium, low, etc.), and the like. In an illustrative embodiment, the modified URL can include at least a portion of the popularity information in the URL. Alternatively, the modified URL can include one or more identifiers that allow the CDN service provider **106** to obtain the appropriate popularity information. One skilled in the relevant art will appreciate that the name information and the path information is not accessible to a DNS nameserver as a part of DNS query processing. Accordingly, the portion of the URL including the domain and any preceding information is generally referred to as the "DNS portion" of the URL.

Additionally, the modified URL can include any additional information utilized by the CDN service provider **106** during the request routing information, including, but not limited to, content provider IDs, service plan information, file identifiers, and the like. The modified URL would have the form of:

http://additional_information.popularity_information.cdnprovider.com/path/resource.xxx

In another embodiment, the information associated with the CDN service provider **106** is included in the modified URL, such as through prepending or other techniques, such that the modified URL can maintain all of the information associated with the original URL. In this embodiment, the modified URL would have the form of:

http://additional_information.popularity_information.cdnprovider.com/www.contentprovider.com/path/resource.xxx

In both of the above examples, the popularity information and additional information are separated as separate labels in the modified URL. One skilled in the relevant art will appreciate that the popularity information and any additional information can be combined together in a single label of the modified URL. Additionally, the popularity information may be omitted from the modified URL and obtained by the CDN service provider **106** during the request routing process, such as a lookup according to a content provider identifier or resource identifier included in a DNS portion of the modified URL (e.g., additional_information.popularity_information.com).

In an alternative embodiment, the additional information provided by the CDN service provider **106** may include translation request code. In this illustrative embodiment, as will be explained in greater detail below with regards to FIGS. **4**A-**4**C, the translation request code may correspond to data or instructions that are processed by the client computing devices **102** to cause the client computing devices **102** to request translation information. In an illustrative embodiment, the translation request code can correspond to script-based instructions that are processed by a browser software application on the client computing device **102** that causes the browser software application to request translation information from one or more of the CDN service provider **106**, the content provider **104**, third party computing devices (such as a Web service), and the like. The requested translation information may be used by the client computing device to resolve embedded resource identifiers (e.g., by substituting an IP address) or to modify the embedded resource identifiers to include popularity information. One skilled in the relevant art will appreciate, however, that the translation request code can be embodied in any one of a variety of executable code formats.

With reference now to FIG. **3**A, after completion of the registration and translation processes illustrated in FIG. **2**, a client computing device **102** subsequently generates a content request that is received and processed by the content provider **104**, such as through the Web server **110**. In accordance with an illustrative embodiment, the request for content can be in accordance with common network protocols, such as the hypertext transfer protocol ("HTTP").

Upon receipt of the content request, the content provider **104** identifies the appropriate responsive content. In an illustrative embodiment, the requested content can correspond to a Web page that is displayed on the client computing device **102** via the processing of information, such as hypertext markup language ("HTML"), extensible markup language ("XML"), and the like. The requested content can also include a number of embedded resource identifiers, described above, that correspond to resource objects that should be obtained by the client computing device **102** as part of the processing of the requested content.

In an embodiment, the embedded resource identifiers will generally be in the form of the modified URLs, described above. Alternatively, the embedded resource identifiers can remain in the form of the content provider URLs that would be received and processed by a DNS nameserver associated with the content provider **104**. In this alternative embodiment, the receiving DNS nameserver would use a canonical name record ("CNAME") that would identify the network storage component **114**. Upon receipt of the returned CNAME, the client computing device **102** subsequently transmits a DNS query corresponding to the received CNAME. The client computing device **102** can then process the received CNAME in a manner similar to the modified URLs, described below. For ease of illustration, however, the alternative embodiment will not be described in further detail and the additional processing steps will only be described with regard to the modified URL. One skilled in the relevant will appreciate that the below description may be applicable to CNAMEs as described in the alternative embodiment.

Upon receipt of the requested content containing modified URLs, the client computing device **102**, such as through a browser software application, begins processing any of the markup code included in the content and attempts to acquire the resources identified by the embedded resource identifiers. Accordingly, the first step in acquiring the content corresponds to the issuance, by the client computing device **102** (through its local DNS resolver), a DNS query for the modified URL resource identifier that results in the identification of a DNS nameserver authoritative to the "." and the "com" portions of the modified URL. After partially resolving the "." and "com" portions of the embedded URL, the client computing device **102** then issues another DNS query for the resource URL that results in the identification of a DNS nameserver authoritative to the ".cdnprovider" portion of the embedded URL. The issuance of DNS queries corresponding to the "." and the "com" portions of a URL are well known and have not been illustrated.

With reference now to FIG. 3B, in an illustrative embodiment, the successful resolution of the "cdnprovider" portion of the original URL identifies a network address, such as an IP address, of a DNS nameserver associated with the CDN service provider **106**. In one embodiment, the IP address is a specific network address unique to a DNS nameserver component of a POP. In another embodiment, the IP address can be shared by one or more POPs. In this embodiment, a further DNS query to the shared IP address utilizes a one-to-many network routing schema, such as anycast, such that a specific POP will receive the request as a function of network topology. For example, in an anycast implementation, a DNS query issued by a client computing device **102** to a shared IP address will arrive at a DNS nameserver component logically having the shortest network topology distance, often referred to as network hops, from the client computing device. The network topology distance does not necessarily correspond to geographic distance. However, in some embodiments, the network topology distance can be inferred to be the shortest network distance between a client computing device **102** and a POP.

With continued reference to FIG. 3B, a specific DNS nameserver in the DNS component **118** of a POP **116** receives the DNS query corresponding to the original URL from the client computing device **102**. Once one of the DNS nameservers in the DNS component **118** receives the request, the specific DNS nameserver attempts to resolve the request. In an illustrative embodiment, a specific DNS nameserver can resolve the DNS query by identifying an IP address of a cache server component that will process the request for the requested resource. As described above, a selected resource cache component can process the request by either providing the requested resource if it is available or attempt attempting to obtain the requested resource from another source, such as a peer cache server computing device or the origin server **112** of the content provider **104**.

As an alternative to selecting a cache server component, the CDN service provider **106** can maintain sets of various alternative resource identifiers. The alternative resource identifiers can be provided by the CDN service provider **106** to the client computing device **102** such that a subsequent DNS query on the alternative resource identifier will resolve to a different DNS nameserver component within the CDN service provider's network. In an illustrative embodiment, the alternative resource identifiers are in the form of one or more CNAME records. In one embodiment, each CNAME record identifies a domain of the CDN service provider **106** (e.g., "cdnprovider.com" or "cdnprovider-1.com"). As will be explained in greater detail below, the domain in the CNAME does not need to be the same domain found in original URL or in a previous CNAME record. In a manner similar to the information described above, each CNAME record includes the same or different additional information utilized by a receiving DNS nameserver for processing the DNS query (e.g., the additional information).

In an illustrative embodiment, the additional information can include popularity information corresponding to information or criteria utilized by the CDN service provider **106** during the request routing process. The popularity information included in the CNAME can be the same popularity information provided in the modified URL or additional/alternative popularity information obtained by the CDN service provider **106**. Additionally, in embodiments in which popularity information is not provided in the modified URL, the popularity information would correspond to popularity information obtained by the CDN service provider **106** (directly or indirectly). As also described above, the CNAME can also include additional request routing information, (e.g., "request routing information") utilized by the CDN service provider **106**. An illustrative CNAME record can have the form of:

http://additional_information.popularity_information.cdnprovider.com/path/resources.xxx CNAME request_routing_information.popularity_information.cdnprovider.com

In an illustrative embodiment, the CNAME records are generated and provided by the DNS nameservers to direct a more appropriate DNS nameserver of the CDN service provider **106**. As used in accordance with the present disclosure, appropriateness can be defined in any manner by the CDN service provider **106** for a variety of purposes.

In the embodiment illustrated in FIG. 3B, the CDN service provider **106** utilizes the popularity information, at least in part, to identify the more appropriate DNS nameserver of the CDN service provider **106** or generally a POP **116**, **122**, **128**. As previously mentioned, the popularity information may be defined in a variety of ways. The determination of the appropriate DNS nameserver of the CDN service provider **106** as a function of popularity information will depend on the popularity information included in the modified URL or otherwise obtained by the CDN server provider **106**.

In one example, the CDN service provider **106** may determine that requests for highly popular resources should be handled by one or more POPs (e.g., POPs **116**, **122**, **128**) according to geographic or network topology, such as POPs that are located on the edge of the content delivery network. One or more POPs **116**, **122**, **128** may be positioned at the edges of the communications network to which the client computing devices **102** are connected. Depending upon the location of a client computing device **102**, some POPs may be closer to the client computing device than other POPs. In this context, closeness may include, but is not limited to, geographical proximity, network topology, and the like. Accordingly, the CDN service provider **106** utilizes alternative resource identifiers such that subsequent DNS queries according to those alternative resource identifiers for requested resources are received by POPs closer to the client computing device **102**. For popular resources, popularity-based request routing can result in reduced latency and higher service quality. Similarly, the CDN service provider **106** may designate that requests for less popular content are to be directed to POPs **116**, **122**, **128** that are located farther from the client computing device and/or are not distributed.

In other embodiments, the CDN service provider **106** may distribute requests for highly popular resources among one or more POPs (e.g., POPs **116**, **122**, **128**) that possess a high level of resource availability. For example, for highly popular resources requiring above average computation, delays in responding to requests for the resource may arise due to limitations in processing resources at specific POPs. Thus, by utilizing alternative resource identifiers to distribute requests to any POPs having high resource availability, latency due to insufficient computing resources may be reduced.

As described above, in addition to the consideration of popularity information, the CDN service provider **106** can utilize the additional information (e.g., the "additional information") included in the modified URL to select a more appropriate POP. In one aspect, the CDN service provider **106** can utilize the additional information to select from a set of DNS nameservers identified as satisfying routing criteria including, but not limited to, financial cost to content provider **104**, network performance (e.g., "internet weather") service level criteria, content provider specified, etc. In another aspect, the CDN service provider **106** can utilize the additional information to validate the POP selected in accordance with the popularity information or to select an alternative DNS nameserver previously selected in accordance with the popularity information. In still another aspect, the CDN service provider **106** can utilize the additional information to select a set of potentially applicable POPs (e.g., meeting minimum service levels) and then utilize the popularity information to prioritize from the set of potentially applicable POPs.

In one example, the CDN service provider **106** can attempt to direct a DNS query to DNS servers according to geographic criteria. The geographic criteria can correspond to a geographic-based regional service plans contracted between the CDN service-provider **106** and the content provider **104** in which various CDN service provider **106** POPs are grouped into geographic regions. Accordingly, a client computing device **102** DNS query received in a region not corresponding to the content provider's regional plan may be better processed by a DNS nameserver in region corresponding to the content provider's regional plan. In this example, the DNS nameserver component **118** may also obtain geographic information from the client directly (such as information provided by the client computing device or ISP) or indirectly (such as inferred through a client computing device's IP address).

In still a further example, the CDN service provider **106** can attempt to direct a DNS query to DNS servers according to network performance criteria. The network performance criteria can correspond to measurements of network performance for transmitting data from the CDN service provider POPs to the client computing device **102**. Examples of network performance metrics can include network data transfer latencies (measured by the client computing device or the CDN service provider **106**), network data error rates, and the like.

In accordance with an illustrative embodiment, the DNS nameserver maintains a data store that defines CNAME records for various URLs. If a DNS query corresponding to a particular URL matches an entry in the data store, the DNS nameserver component **118** returns a CNAME record as defined in the data store. In an illustrative embodiment, the data store can include multiple CNAME records corresponding to a particular original URL. The multiple CNAME records would define a set of potential candidates that can be returned to the client computing device. In such an embodiment, the DNS nameserver component **118**, either directly or via a network-based service, can implement additional logic in selecting an appropriate CNAME from a set of possible of CNAMEs. In an illustrative embodiment, each DNS nameserver component **118**, **124**, **130** maintains the same data stores that define CNAME records, which can be managed centrally by the CDN service provider **106**. Alternatively, each DNS nameserver component **118**, **124**, **130** can have POP specific data stores that define CNAME records, which can be managed centrally by the CDN service provider **106** or locally at the POP **116**, **122**, **128**.

The returned CNAME can also include request routing information that is different from or in addition to the information provided in URL/CNAME of the current DNS query. For example, if the CNAME selection is based on a regional plan, a specific regional plan can be identified in the "request_routing_information" portion of the specific CNAME record. A similar approach could be taken to identify service level plans and file management by including a specific identifier in the "request_routing_information" portion of the CNAME record. In another embodiment, request routing information can be found in the identification of a CDN service provider **106** domain different from the domain found in the current URL/CNAME. For example, if the CNAME is based on a regional plan, a specific regional plan domain (e.g., "cdnprovider-region1.com") could be used in the domain name portion of the specific CNAME record. Any additional request routing information can be prepended to the existing request routing information in the current URL/CNAME such that the previous request routing information would not be lost (e.g., serviceplan.regionalplan.cdnprovider.com). One skilled in the relevant art will appreciate that additional or alternative techniques and/or combination of techniques may be used to include the additional request routing information in the CNAME record that is selected by the DNS nameserver component **118**.

With continued reference to FIG. **3**B, the DNS nameserver component **118** may select (or otherwise obtain) a CNAME record that is intended to resolve to a more appropriate DNS nameserver of the CDN service provider **106**. In may be possible, however, that the same DNS nameserver would also be authoritative for the subsequent DNS query for the CNAME to be provided to the client computing device. For example, a specific DNS nameserver may be authoritative for both a specific regional plan and a service level plan. Thus, returning a CNAME would still result in the DNS query arriving at the same DNS query (may be due in part to the client computing device's geography). In such an embodiment, the DNS nameserver, such as DNS nameserver component **118**, may choose to resolve the future DNS query in advance.

With reference now to FIG. **3**C, upon receipt of the CNAME from the DNS nameserver component **118**, the client computing device **102** generates a subsequent DNS query corresponding to the CNAME. As previously discussed with regard to FIG. **3**B, the DNS query process could first start with DNS queries for the "." and "com" portions, followed by a DNS query for the "cdnprovider" portion of the CNAME. To the extent, however, that the results of previous DNS queries can be cached (and remain valid), the client computing device **102** can utilize the cached information and does not need to repeat the entire process. However, at some point, depending on whether the CNAME provided by the DNS nameserver component **118** (FIG. **3**B) and the previous URL/CNAME share common CDN service provider domains, resolves to a different POP provided by the CDN service provider **106**. As illustrated in FIG. **3**C, the DNS nameserver component **124** of POP **122** is now authoritative based on the different information in the current CNAME previously provided by the DNS nameserver component **118**. As previously described, the DNS nameserver component **124** can then determine whether it is authoritative to resolve the DNS query on the entire CNAME by providing a responsive IP address of a cache component that will process the content request or whether to provide another alternative resource identifier selected in the manner described above. As described above, the DNS nameserver remains operative to receive DNS queries on behalf of the CDN service provider **106** even if it is not authoritative to fully resolve the DNS query by providing an IP address.

For purposes of illustration, assume that the DNS nameserver component **118** determines that the DNS query corresponding to the current CNAME (provided by DNS nameserver component **116**) also corresponds to a CNAME record in its data store. In such an example, the DNS nameserver component **124** would do any necessary processing to select a specific CNAME and return the CNAME to the client computing device. With reference now to FIG. **3**D, the client computing device **102** would now transmit a second subsequent DNS query corresponding to the CNAME provided by DNS nameserver component **124** (FIG. **3**C). In accordance with DNS query processes already described, the DNS query would illustratively be received by the DNS nameserver component **130** of POP **128**. Again, the DNS nameserver component **130** can then determine whether to resolve the DNS query on the CNAME with an IP address of a cache component that will process the content request or whether to provide another alternative resource identifier selected in the manner described above. In this example, the DNS nameserver component **130** returns an IP address.

In an illustrative embodiment, the DNS nameserver components, such as DNS nameserver component **130**, can utilize a variety of information in selecting a resource cache component. In one example, the DNS nameserver component can default to a selection of a resource cache component of the same POP. In another example, the DNS nameserver components can select a resource cache component based on various load balancing or load sharing algorithms. Still further, the DNS nameserver components can utilize network performance metrics or measurements to assign specific resource cache components. The IP address selected by a DNS nameserver component may correspond to a specific caching server in the resource cache. Alternatively, the IP address can correspond to a hardware/software selection component (such as a load balancer).

With reference now to FIG. **3**E, in an illustrative example, assume that the DNS nameserver component **130** has resolved to received DNS query by returning the IP address of the resource cache component **132** of POP **128**. Upon receipt of the IP address for the resource cache component **132**, the client computing device **102** transmits requests for the requested content to the resource cache component **132**. The resource cache component **132** processes the request in a manner described above and the requested resource is transmitted to the client computing device **102**.

In an alternative embodiment, with reference now to FIGS. **4**A-**4**C, the content provider **104** may utilize executable code, such as translation request code, for facilitating request routing utilizing popularity information. The translation request code may direct a client computing device **102** to request further translation request code and/or translation information. In an embodiment, the translation request code may direct the client computing device **102** to request the translation request code from a CDN service provider **106**. Alternatively, the translation request code may direct the client computing device **102** to request the translation request code from the content provider **104**, from a third party computing device, and combinations thereof. For example, a third party independent broker may provide different translation request code based on a selection among several CDN service providers **106**. Illustratively, embodiments in which the translation request code directs the client computing device **102** to request further translation request code and/or translation information from a CDN service provider **106** are discussed below and illustrated in FIGS. **4**A-**4**C.

In certain embodiments, the translation information may provide the client computing device **102** with modified resource identifiers or other information containing popularity information that causes the modification of resource identifiers that may be resolved through DNS queries to identify a resource cache component of a POP from which the requested resource may be obtained. In other embodiments, the translation information may directly identify, at least as a function of popularity information of the requested content, a resource cache component from which the requested resource may be obtained. In this embodiment, the translation information corresponds to a location of the embedded resource identifier by providing an IP address.

In an illustrative embodiment, the translation request code can be applicable to multiple content providers **104**. Alternatively, the translation request code can be unique to each particular content provider **104**. Still further, the CDN service provider **106** may provide additional logic to the content providers **104** that controls the circumstances and/or methodologies for embedding the translation request code into content. For example, the translation request code can include instructions (or executable code) that defines that the type of content (e.g., specific Web pages) for which the translation request code will apply. These and other embodiments are discussed in detail below.

With reference now to FIG. **4**A, after completion of the registration processes illustrated in FIG. **2**, a client computing device **102** subsequently generates a content request that is received and processed by the content provider **104**, such as through the Web server **110**. In accordance with an illustrated embodiment, the request for content may be in accordance with common network protocols, such as the hypertext transfer protocol ("HTTP"). Upon receipt of the content request, the content provider **104** identifies the appropriate responsive content. In an illustrative embodiment, the requested content can correspond to a Web page that is displayed on the client computing device **102** via the processing of information, such as hypertext markup language ("HTML"), extensible markup language ("XML"), and the like. The requested content may further include a number of embedded resource identifiers, as described above, that correspond to resource objects that should be obtained by the client computing device **102** as part of the processing of the requested content.

The requested content will also include embedded translation request code provided to the content provider **104** by the CDN service provider **106** during the registration process. In an illustrative embodiment, the embedded execution code can be arranged in a manner such that it is processed prior to processing any other of the content in the requested content or processed in the earlier stages of the processing of the requested content, as allowed. The identification of the resources provided by the content provider **104** will be in the form of a resource identifier that can be processed by the client computing device, such as through a browser software application, as discussed above. Further, the resource identifiers may be in the form of URLs.

As described above, in an embodiment, the translation request code can include script-based instructions and information that instructs a browser software application on the client computing device **102** to generate a request for translation information for embedded resources within the content. For example, the translation request code may include one or more resource identifiers (e.g., URLs) that identify an applicable domain from which such script-based instructions may be obtained. In reference to an embodiment illustrated in FIG. **4**B, the translation code processed by the client computing device **102** may instruct the client computing device **102** to query the CDN service provider **106** for additional translation code.

It may be understood that, in certain embodiments, the translation code received from the content provider **104** may contain the entirety of the necessary translation code. Therefore, requests for additional translation code may be omitted.

With reference to FIG. **4**C, upon receipt of the translation request code, the client computing device **102** processes the translation request code in a manner that causes the client computing device **102** to request translation information from the CDN service provider **106**. The translation information request can include information identifying the content provider **104**, the specific client computing device **102**, the type/size of requested resources (e.g., large image files), and additional information that could be used by the CDN service provider **106** to determine an appropriate POP for providing requested resources. In an example, the additional information may include popularity information included as part of the resource identifiers, as discussed above. In other examples, the request for translation information can include network topology and/or network performance information accumulated by the client computing device **102** or measured during the transmission of the request. Still further, some of the information may be inferentially obtained by the CDN service provider **106**. For example, a client computing device **102** geographic location may be inferred from an Internet Protocol ("IP") address associated with the client computing device.

As further illustrated in FIG. **4**C, the translation information request can be directed to a specific POP, such as POP **116**, provided by the CDN service provider **106**. In one embodiment, the translation request code can include a listing of one or more specific network addresses, such as IP addresses, on POPs that can process the request for translation information. In another embodiment, the translation request code can include a single network address shared by one or more POPs such that a request for the translation information utilizes a one-to-many network routing schema, such as anycast, such that a specific POP will receive the request as a function of network topology. In both this embodiment and the previous embodiment, the network address may correspond to a particular computing device in the POP or may correspond generally to the POP. Still further, in an alternative embodiment, the CDN service provider **106** may maintain a computing device separate from a POP for processing translation information requests from client computing devices **102**.

Upon receipt of the translation information request, the CDN service provider **106**, such as through a POP **116**, may generate or obtain translation information that will be used to process the original URLs associated with the embedded objects. In an illustrative embodiment, the translation information corresponds to information that will be used to modify the URL for subsequent processing by the CDN service provider **106**. Such information may include the identification of one or more domain names associated with the CDN service provider **106** that will cause the request for content to be resolved to the CDN service provider **106** and not the content provider **104**. The translation information can also include additional information processing information that allows the CDN service provider **106** to select which POP, resource cache component or specific cache server computing device will provide requested content. As previously described, the additional information includes popularity information included in the resource identifier. For example, the popularity information may comprise measurements of resource popularity made by the CDN service provider **106** and/or POPs **116**, **122**, **128**.

In another example, the translation information request may identify a network address, such as an IP address, from which the CDN service provider **106** may retrieve the popularity information. In other examples, in addition to the popularity information, the translation information can include information including, but not limited to, identification of the specific content provider, a particular regional coverage plan associated with the content provider **104**, service level plans associated with the content provider, a geographic location/region associated with the client computing device, and the like.

The translation information can further include rules or other information that specifies the applicability of the various identified domains/IP addresses to the original URLs, the manner in which an original URL is to be modified, expiration timeframes for the translation information and the like. The translation information is then returned to the requesting client computing device **102**.

With further reference to FIG. **4**C, the client computing device **102** receives and processes the translation information from the CDN service provider **106**. In one embodiment, the translation information can include data, or other information, that is processed by code existing on the client computing device **102**. For example, the client computing device **102** may be executing a software application configured specifically for the processing of the translation code. Similarly, the translation execution code previously executed by the client computing device **102** may include executable instructions for processing the translation information. Alternatively, the translation information can include executable instructions, such as script-based instructions, that cause the client computing device **102**, such as through a browser software application, to process other data in the translation information.

As described above, the processing of the translation information may result in the modification, or replacement, of the original URL, referred to generally as the translated identifier. In one embodiment, the translation process results in the identification of an IP address of a cache server component, selected based upon the population information, that will process the request for the associated resource. In this embodiment, no additional translation or URL processing steps are required. In accordance with an illustrative embodiment related to a translated identifier that is an IP address, the request for content may be directly sent to the cache server associated by the translated IP address, as discussed above with respect to FIG. **3**E.

In another embodiment, the processing of the translated information results in the generation of a URL that includes the popularity information for the requested resource and may require additional processing. Specifically, in this embodiment, the translated identifier is a translated URL modified such that requests for the resources associated with the translated URLs resolve to a POP associated with the CDN service provider **106** that is selected, at least in part, based upon the popularity information, as discussed above with respect to FIGS. **3**B-**3**D. Upon translating the identifier to an IP address, the request for content may be sent directly to the cache server associated by the translated IP address, as discussed with respect to FIG. **3**E.

As previously described, the translation information can further include rules, or other processing information, that can specify which original URLs should be modified and/or the translation information that can be used to modify specific original URLs. Still further, in another embodiment, the processing of the requested content from the content provider **104** may result in the request of the embedded original URLs prior to the receipt of the translation information from the CDN service provider **106**. In one approach, the client computing device **102** may issue one or more resource requests according to the information in the original URL until the translation information is received and any remaining original URLs can be translated. In another approach, the original URLs can correspond to non-functional resource identifiers that can only be processed upon completion of the translation process. In still a further approach, the original URLs can correspond to intermediary resource identifiers that can be partially processed by the computing device **102** upon the initial processing of the requested content but that can only be finalized after completion of the translation process. One skilled in the relevant art will appreciate that the particular technique for translation and the management of URL translation in advance of the issuance of resource requests may vary according to the type of software application generating the resource requests, the specific capabilities of the networking protocol, the specific rules associated with the processing of the markup language (or other information) of the requested content, and the combination thereof.

With reference now to FIG. **5**A, a resource identifier processing routine **500** implemented by a client computing device **102** to process embedded resource identifiers with translation information will be described. At block **502**, the client computing device **102** transmits the original request for content. As described above, the request for content may be directed to a Web server **110** of the content provider **104**. At block **504**, the client computing device **102** obtains responsive content that includes translation request code. As described above, in an illustrative embodiment, the translation request code can correspond to script-based instructions that can be processed by a software application running on the client computing device **102**. Still further, the translation request code can be organized in the responsive content such that the translation request is the first (in accordance with the limitations of the limitations/capabilities of the networking protocols and markup language) data processed by the client computing device **102**.

In certain embodiments, the translation request code may direct the client computing device **102** to request further translation request code from the CDN service provider **106**, content provider **104**, or third party computing device. In other embodiments, the translation code received from the content provider **104** within the resource may contain the entirety of the necessary translation code and requests for additional translation code may be omitted.

At block **506**, the client computing device **102** transmits the request for translation information to the CDN service provider **106** identified in the translation execution code. As previously described, the request for translation information can include information that may be used by the CDN service provider **106** to generate, or select, the translation information. The additional information may be specifically included in the request for translation or inferred from aspects of the request (e.g., IP address of the client computing device **102**). At block **508**, the client computing device **102** obtains translation information from the CDN service provider **106** that is based upon popularity information.

At block **510**, the client computing device **102** processes the embedded resource identifiers with the translation information. As previously described, the translation information can include data utilized to another software application to process the embedded, original URLs (such as a stand alone software application). Alternatively, the translation information can include instructions (such as script-based instructions) that call a software application (such as a browser application) to process the remaining portions of the translation information.

As also previously described, the processing of the original, embedded URLs can correspond to the modification (including replacement) of the URLs. For example, the embedded URLs may be modified such that at least a portion of the popularity information associated with the embedded resource is incorporated in the modified URL. Furthermore, using the modified URL, a request for the resource associated with the embedded resource resolves to a POP associated with the CDN service provider **106** that is selected using the popularity information within the modified URL.

At block **512**, the client computing device **102** transmits requests for the resources associated with the translated URLs. In an illustrative embodiment, the request for the resources associated with the translated URLs can be facilitated through various networking protocols. At block **514**, the routine **500** terminates.

With reference now to FIG. **5**B, an alternative embodiment of a resource identifier processing routine **550** implemented by a client computing device **102** to process embedded resource identifiers with translation information will be described. At block **552**, client computing device **102** transmits the original request for content. The request for content may be directed to a Web server **110** of the content provider **104**. At block **554**, the client computing device **102** obtains responsive content that includes translation request code. As described above, in an illustrative embodiment, the translation request code can correspond to script-based instructions that can be processed by a software application running on the client computing device **102**. Still further, the translation request code can be organized in the responsive content such that the translation request is the first (in accordance with the limitations of the limitations/capabilities of the networking protocols and markup language) data processed by the client computing device **102**.

In certain embodiments, the translation request code may direct the client computing device **102** to request further translation request code from the CDN service provider **106**, content provider **104**, or third party computing device. In other embodiments, the translation code received from the content provider **104** within the resource may contain the entirety of the necessary translation code and requests for additional translation code may be omitted.

At block **556**, the client computing device **102** transmits the request for translation information to the CDN service provider **106** identified in the translation execution code. As previously described, the request for translation information can include information that may be used by the CDN service provider **106** to generate, or select, the translation information. The additional information may be specifically included in the request for translation or inferred from aspects of the request (e.g., IP address of the client computing device **102**). At block **558**, the client computing device **102** obtains translation information from the CDN service provider **106** that is based upon popularity information.

In block **560**, the client computing device **102** processes the received translation information. In an embodiment, the processing of the original, embedded URLs can correspond to the modification (including replacement) of the URLs, where the original URLs may be directly translated into an IP address of a cache server component.

Subsequently, the processing routine **550** may transmit a request for the embedded resources using the IP address of the cache server component identified using the popularity information within the translation information in block **562**. Beneficially, further DNS resolution is not necessary, as the translation information provides the network address information necessary to obtain the embedded resources directly. At block **564**, the routine **550** terminates.

With reference now to FIG. **6**, an embodiment of a translation information processing routine **600** implemented by a client computing device **102** that receives translation information from a CDN service provider **106** for translating content will be described. At block **602**, the content is parsed and a resource identifier embedded in the content is selected.

In decision block **604**, rules or other processing information contained within the translation information are reviewed in view of the selected resource identifier. If the rules indicate that the resource identifier is not to be changed, the routine **600** moves to block **614**, while if the translation information indicates that the resource identifier is to be changed, the routine **600** moves to block **606**.

In decision block **606**, a test is conducted to determine whether the embedded resource identifier is to be replaced or modified. Such a determination may be made by reviewing the translation information pertaining to the selected embedded resource identifier to determine how the original, selected resource identifier is to be changed. If the translation information indicates that the embedded resource identifier is to be replaced, the client computing device **102** replaces the original embedded resource identifier with a new resource identifier according to the translation information in block **610**. In certain embodiments, the new resource identifier information may be a network address, such as an IP address determined by the CDN service provider **106** according to the popularity of the resource, that may provide the client computing device with the resource associated with the original resource identifier. The routine **600** continues in block **614**.

Alternatively, if the translation information indicates that the embedded resource identifier is to be modified, the client computing device **102** modifies the original embedded resource identifier according to the translation information in block **612**. For example, as discussed above, a resource identifier including a URL may be modified so as to identify the domain of the CDN service provider **106**, the name of the resource to be requested, the path where the resource will be found, and additional information including, but not limited to, the popularity of the resource. The routine **600** then continues in block **614**.

In decision block **614**, a test is conducted to determine whether additional embedded resource identifiers are present within the content that require processing. If so, the routine **600** then returns to block **602**, and continues to repeat as appropriate. Alternatively, if additional embedded resource identifiers are not present within the content that require processing the routine **600** ends.

With reference now to FIG. **7**, an embodiment of a request routine **700** implemented by the CDN provider **106** will be described. One skilled in the relevant art will appreciate that actions/steps outlined for routine **700** may be implemented by one or many computing devices/components that are associated with the CDN service provider **106**. Accordingly, routine **700** has been logically associated as being performed by the CDN service provider **106**.

At block **702**, one of the DNS nameserver components **118**, **124**, **130** obtains a DNS query corresponding to resource identifier (the "receiving DNS nameserver"). As previously discussed, the resource identifier can be a URL that has been embedded in content requested by the client computing device **102** and previously provided by the content provider **104**. Alternatively, the resource identifier can also correspond to a CNAME provided by a content provider DNS nameserver in response to a DNS query previously received from the client computing device **102**. At block **704**, the receiving DNS nameserver obtains popularity information associated with the requested resource. As described above, in an illustrative embodiment, the popularity information may be included, at least in part, in the modified URL or CNAME. Such popularity information may specify that the CDN service provider **106** should utilize popularity information in attempting to resolve the DNS query. Alternatively, the popularity information may specify specific service criteria to be utilized by the CDN service provider in attempting to resolve the DNS query. In another embodiment, the receiving DNS nameserver can obtain the popularity information, or portion thereof, according to a client identifier including the "additional information" or "request routing information" labels of the modified URL or CNAME, respectively.

At decision block **706**, a test is conducted to determine whether the current DNS nameserver is authoritative to resolve the DNS query. In one illustrative embodiment, the DNS nameserver can determine whether it is authoritative to resolve the DNS query if there are no CNAME records corresponding to the received resource identifier. For example, based on the receiving DNS nameserver may maintain one or more CNAMEs that define various popularity alternatives for request routing processing. In this embodiment, the receiving DNS can utilize the popularity information obtained in block **704** to select the appropriate CNAME. Alternatively, the receiving DNS may select a CNAME without requiring additional information from the URL or CNAME. As previously discussed, the selection of the appropriate CNAME corresponding to the alternative POP will depend in part on the popularity information processed by the CDN service provider **106**. Alternative or additional methodologies may also be practiced to determine whether the DNS nameserver is authoritative.

In one example, the popularity information may designate that the requested resource is relatively popular. In response, the DNS nameserver may select a CNAME that corresponds to a DNS nameserver (e.g. POP) for purposes of facilitating increased performance for subsequent requests for the resource from a cache component. For example, the DNS nameserver may select a CNAME corresponding to a DNS nameserver that is relatively close to the client computing device **102**. In this manner, the communication time necessary to respond to DNS queries for the requested resource may be reduced.

In another example, the DNS nameserver may select a CNAME that corresponds to a DNS nameserver (e.g. POP) for purposes of redistributing a request for a highly popular resource among one or more POPs (e.g., POPs **116**, **122**, **128**) that possess a high level of resource availability. Delays in responding to requests for the resource may arise if limitations in processing resources are encountered. By distributing resource requests among POPs having high resource availability, though, latency due to insufficient computing resources may be reduced.

Conversely, the popularity information may designate that the requested resource is relatively less popular. In response, the DNS nameserver may select a CNAME corresponding to a DNS nameserver for purposes of selecting a DNS nameserver farther from the client computing device and/or to one or more POPs that possess lower levels of resource availability. This selection reflects that less popular content is routed with less priority than more popular content.

In addition to the popularity information, additional information may also be considered in selection of the CNAME provided by the DNS nameserver. Examples may include, routing criteria that include, but are not limited to, financial cost to the content provider **104**, network performance service level criteria, content provider specified criteria, and the like.

If the current DNS nameserver is authoritative (including a determination that the same DNS nameserver will be authoritative for subsequent DNS queries), the current DNS nameserver resolves the DNS query by returning the IP address of cache server component at block **708**. In a non-limiting manner, a number of methodologies for selecting an appropriate resource cache component have been previously discussed. Additionally, as described above, the IP address may correspond to a specific cache server of a resource cache component or generally to group of cache servers.

Alternatively, if at decision block **706**, the DNS nameserver is not authoritative, at block **710**, the DNS nameserver component selects and transmits an alternative resource identifier. As described above, the DNS nameserver component can utilize a data store to identify an appropriate CNAME as a function of the current DNS query. Additionally, the DNS nameserver component can also implement additional logical processing to select from a set of potential CNAMES. At block **712**, different DNS nameserver components **118**, **124**, **130** receive a DNS query corresponding to the CNAME. The routine **700** then returns to decision block **706** and continues to repeat as appropriate.

Although routine **700** has been illustrated with regard to the utilization of alternative resource identifiers (e.g., CNAMES) to facilitate the request routing processing to different DNS servers within the CDN server provider **106** network, one skilled in the relevant art will appreciate that CDN service provider **106** may utilize popularity information included in the modified URL to resolve DNS queries without utilizing an alternative resource identifier. In such an embodiment, the CDN service provider would utilize a communication network and protocol to facilitate the forwarding of DNS queries selected according to popularity information.

While illustrative embodiments have been disclosed and discussed, one skilled in the relevant art will appreciate that additional or alternative embodiments may be implemented within the spirit and scope of the present invention. Additionally, although many embodiments have been indicated as illustrative, one skilled in the relevant art will appreciate that the illustrative embodiments do not need to be combined or implemented together. As such, some illustrative embodiments do not need to be utilized or implemented in accordance with scope of variations to the present disclosure.

Conditional language, such as, among others, "can," "could," "might," or "may," unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or steps. Thus, such conditional language is not generally intended to imply that features, elements and/or steps are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without user input or prompting, whether these features, elements and/or steps are included or are to be performed in any particular embodiment.

Any process descriptions, elements, or blocks in the flow diagrams described herein and/or depicted in the attached figures should be understood as potentially representing modules, segments, or portions of code which include one or more executable instructions for implementing specific logical functions or steps in the process. Alternate implementations are included within the scope of the embodiments described herein in which elements or functions may be deleted, executed out of order from that shown or discussed, including substantially concurrently or in reverse order, depending on the functionality involved, as would be understood by those skilled in the art. It will further be appreciated that the data and/or components described above may be stored on a computer-readable medium and loaded into memory of the computing device using a drive mechanism associated with a computer-readable medium storing the computer executable components such as a CD-ROM, DVD-ROM, or network interface. Further, the component and/or data can be included in a single device or distributed in any manner. Accordingly, general purpose computing devices may be configured to implement the processes, algorithms and methodology of the present disclosure with the processing and/or execution of the various data and/or components described above.

It should be emphasized that many variations and modifications may be made to the above-described embodiments, the elements of which are to be understood as being among other acceptable examples. All such modifications and variations are intended to be included herein within the scope of this disclosure and protected by the following claims.

What is claimed is:

1. A system comprising:

at least one computing device corresponding to a content delivery network (CDN) provider and operative to:

receive a request, generated by a client computing device, for translation information for a resource identifier originally provided to the client computing device by a content provider;

generate translation information responsive to the request, wherein the translation information provides instructions for the client computing device to generate a modified resource identifier by modifying the resource identifier to include information pertaining to popularity of the requested resource; and

cause transmission of the translation information to the client computing device.

2. The system of claim **1**, wherein the resource identifier and modified resource identifier are uniform resource locators.

3. The system of claim **2**, wherein at least a portion of the popularity information is included in the uniform resource locator of the modified resource identifier.

4. The system of claim **3**, wherein the at least a portion of the popularity information is included in a DNS portion of the uniform resource locator of the modified resource identifier.

5. The system of claim **2**, wherein the modified resource identifier includes at least a portion of the uniform resource locator of the resource identifier.

6. The system of claim **1**, wherein the translation information request comprises popularity information.

7. The system of claim **6**, wherein the popularity information of the translation information request is included as a part of the resource identifier.

8. The system of claim **1**, wherein the popularity information is retrieved from the CDN provider.

9. The system of claim **8**, wherein the popularity information comprises a frequency of received resource requests.

10. The system of claim **1**, wherein modification of the resource identifier includes replacement of the resource identifier.

11. A computer-implemented method comprising:

as implemented by one or more computing devices configured with specific executable instructions, the one or more computing devices corresponding to a content delivery network (CDN) provider,

receiving a request for translation information for a resource identifier originally provided to the client computing device by a content provider;

generating translation information responsive to the request, wherein the translation information provides instructions for the client computing device to generate a modified resource identifier by modifying the resource identifier to include information pertaining to popularity of the requested resource; and causing transmission of the translation information to the client computing device.

12. The computer-implemented method of claim **11**, wherein the resource identifier and modified resource identifier are uniform resource locators.

13. The computer-implemented method of claim **12**, wherein at least a portion of the popularity information is included in the uniform resource locator of the modified resource identifier.

14. The computer-implemented method of claim **13**, wherein the at least a portion of the popularity information is included in a DNS portion of the uniform resource locator of the modified resource identifier.

15. The computer-implemented method of claim **12**, wherein the modified resource identifier includes at least a portion of the uniform resource locator of the resource identifier.

16. The computer-implemented method of claim **11**, wherein the translation information request comprises popularity information.

17. The computer-implemented method of claim **16**, wherein the popularity information of the translation information request is included as a part of the resource identifier.

18. The computer-implemented method of claim **11**, wherein the popularity information is retrieved from the CDN provider.

19. The computer-implemented method of claim **18**, wherein the popularity information comprises a frequency of received resource requests.

20. The computer-implemented method of claim **11**, wherein modification of the resource identifier includes replacement of the resource identifier.

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